Tucannon River Spring Chinook Salmon Hatchery Evaluation Program

2002 Annual Report

by

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Prepared for:

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Cooperative Agreement: 1411-02-J050

August 2003

Acknowledgments

The Tucannon River Spring Chinook Salmon Hatchery Evaluation Program is the result of efforts by many individuals within the Washington Department of Fish and Wildlife (WDFW) and from other agencies.

We would like to express sincere gratitude to Don Peterson, Lyons Ferry Complex Manager, for his coordination efforts. We thank Hatchery Specialists Doug Maxey and Dick Rogers for their cooperation with hatchery sampling, providing information regarding hatchery operations and hatchery records, and their input on evaluation and research activities. We also thank all additional hatchery personnel who provide the day-to-day care of the spring chinook and for their assistance with hatchery spawning, sampling, and record keeping.

We thank Lynn Anderson and the Coded-Wire Tag Lab staff for their assistance in coded-wire tag verification and Julie Hooff for tagging the supplementation and captive brood fish. We also thank John Sneva for reading scales, and Steve Roberts for providing information on fish health issues that arose during the year.

Megan Heinrich from the Idaho Cooperative Fish and Wildlife Research Unit-University of Idaho provided radio tags for tagging the captive brood adult outplants.

We thank the staff of the Snake River Lab, in particular Debbie Milks, Jerry Dedloff, and our temporary technicians Mike Herr, Justin Steinhoff, and Amber Steinhoff who helped collect the information presented in this report.

We thank Mark Schuck, Joe Bumgarner, Glen Mendel, Todd Pearsons, and Jim Scott for providing critical reviews of the draft report.

The supplementation program was funded by the United States Fish and Wildlife Service through the Lower Snake River Compensation Plan Office. The captive broodstock program was funded through BPA.

Abstract

Lyons Ferry Hatchery (LFH) and Tucannon Fish Hatchery (TFH) were built/modified under the Lower Snake River Fish and Wildlife Compensation Plan. One objective was to compensate for the estimated annual loss of 1,152-spring chinook (Tucannon River stock) caused by hydroelectric projects on the Snake River. The standard supplementation production goal is 132,000 fish for release as yearlings at 30 g/fish or 15 fish per pound (fpp). The captive brood production goal is 150,000 yearlings at 30 g/fish. This report summarizes activities of the Washington Department of Fish and Wildlife Lower Snake River Hatchery Evaluation Program for Tucannon River spring chinook for the period April 2002 to April 2003.

Seven hundred seventy-eight fish were captured in the TFH trap in 2002 (166 natural adults, 2 natural jacks, 589 hatchery adults, and 21 hatchery jacks); 107 were collected and hauled to LFH for broodstock and the remaining fish were passed upstream.

During 2002, two salmon that were collected for broodstock died. Prespawning mortality has been low since broodstock began being held at LFH in 1992, and is generally less than 10% each year.

Spawning of supplementation fish in 2002 at LFH occurred between August 27 and September 17, with peak eggtake on September 3. A total of 169,364 eggs were collected from 22 wild and 25 hatchery-origin fish. Egg mortality to eye-up was 3.6% (6,047 eggs), with an additional loss of 11,786 (7.2%) sac-fry. Total fry ponded for production in the rearing ponds was 151,531.

A total of 121 captive brood females were spawned from August 27 to October 2, 2002 producing 176,544 eggs. Egg mortality to eye-up was 68% leaving 55,711 live eggs. An additional 5,249 dead eggs/fry (9.4%) were picked at ponding leaving 50,462 fish for rearing.

One spring chinook salmon that was radio tagged at Bonneville Dam entered the Tucannon River in 2002. This fish entered the adult trap on June 12 and was passed upstream by hatchery personnel. Efforts to locate this fish after it was passed upstream were unsuccessful. The radio tag either quit working or the fish/transmitter left the area.

On August 20, 97 excess captive broodstock were released at Panjab Bridge. All released fish were Monel jaw tagged and radio transmitters were inserted into ten of the largest fish. Only two of the radio tagged females spawned and released captive brood were observed being dominated by hatchery and wild fish in the river.

WDFW staff conducted spawning ground surveys in the Tucannon River between August 22 and October 7, 2002. One hundred ninety-seven redds and 140 carcasses were found above the adult trap and 102 redds and 60 carcasses were found below the trap. Based on redd counts,

broodstock collection, and in-river pre-spawning mortalities, the estimated escapement for 2002 was 1,005 fish (341 wild adults, 9 wild jacks and 644 hatchery-origin adults, 11 hatchery jacks).

Length and weight samples were collected three times during the rearing cycle for 2001 BY juveniles at TFH and Curl Lake Acclimation Pond. All 2001 BY juveniles were marked in October at LFH, transported to TFH, and transported again in February to Curl Lake for acclimation and volitional release during March and April.

Snorkel surveys were conducted during the summer of 2002 to determine the population of subyearling and yearling spring chinook in the Tucannon River. We estimated 63,412 subyearlings (BY 2001) and 703 yearlings (BY 2000) were present in the river. Evaluation staff also operated a downstream migrant trap. During the 2001/2002 emigration, we estimated that 20,049 (BY 2000) wild spring chinook smolts emigrated from the Tucannon River.

Monitoring survival rate differences between natural and hatchery-reared salmon continues. Smolt-to-adult return rates (SAR) for natural salmon consistently average about three times higher than for hatchery salmon. However, hatchery salmon survive about four times greater than natural salmon from parent to adult progeny. Due to the low SAR for hatchery fish, the mitigation goal of 1,152 salmon of Tucannon River stock was not achieved.

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Introduction

Program Objectives

Congress authorized implementation of the Lower Snake River Fish and Wildlife Compensation Plan (USACE 1975). As a result, Lyons Ferry Hatchery (LFH) was constructed and Tucannon Fish Hatchery (TFH) was modified. One objective of these hatcheries is to compensate for the estimated annual loss of 1,152 Tucannon River spring chinook salmon adults caused by hydroelectric projects on the Snake River. In 1984, Washington Department of Fish and Wildlife (WDFW) began to evaluate the success of these two hatcheries in meeting the mitigation goal, and identifying factors that would improve performance of the hatchery fish. The WDFW also initiated the Tucannon River Spring Chinook Captive Broodstock Program in 1997 that is currently funded by the Bonneville Power Administration (BPA). The project goal is to rear captive salmon selected from the supplementation program (1997-2001 BYs) to adults, rear their progeny, and release approximately 150,000 smolts (30 g/fish) annually into the Tucannon River between 2003-2007. These smolt releases, in combination with the current hatchery supplementation program (goal = 132,000 smolts) and wild production, are expected to produce 600-700 returning adult spring chinook to the Tucannon River each year from 2005-2010. This report summarizes work performed by the WDFW Spring Chinook Evaluation Program from April 2002 through April 2003.

Facility Descriptions

Lyons Ferry Hatchery is located on the Snake River (rkm 90) at its confluence with the Palouse River (Figure 1). It is used for adult broodstock holding and spawning, and early life incubation and rearing. All juvenile fish are marked and returned to TFH for final rearing and acclimation. Tucannon Fish Hatchery, located at rkm 59 on the Tucannon River, has an adult collection trap on site (Figure 1). Juveniles rear at TFH through winter. In February, the fish are transported to Curl Lake Acclimation Pond (AP) and volitionally released. The annual supplementation production goal is 132,000 fish for release as yearlings at 30 g/fish or 15 fish per pound (fpp). The captive brood production goal is 150,000 yearling smolts at 30 g/fish.

Tucannon River Watershed Characteristics

The Tucannon River empties into the Snake River between Little Goose and Lower Monumental dams approximately 622 rkm from the mouth of the Columbia River (Figure 1). Stream elevation rises from 150 m at the mouth to 1,640 m at the headwaters (Bugert et al. 1990). Total watershed area is approximately 1,295 km^2. Local habitat problems related to logging, road building, recreation, and agriculture/livestock grazing have limited the production potential of spring chinook in the Tucannon River. Land use in the Tucannon watershed is approximately 36% grazed rangeland, 33% dry cropland, 23% forest, 6% WDFW, and 2% other use (Tucannon Subbasin Summary 2001). Five unique strata have been distinguished by predominant land use, habitat, and landmarks (Table 1).

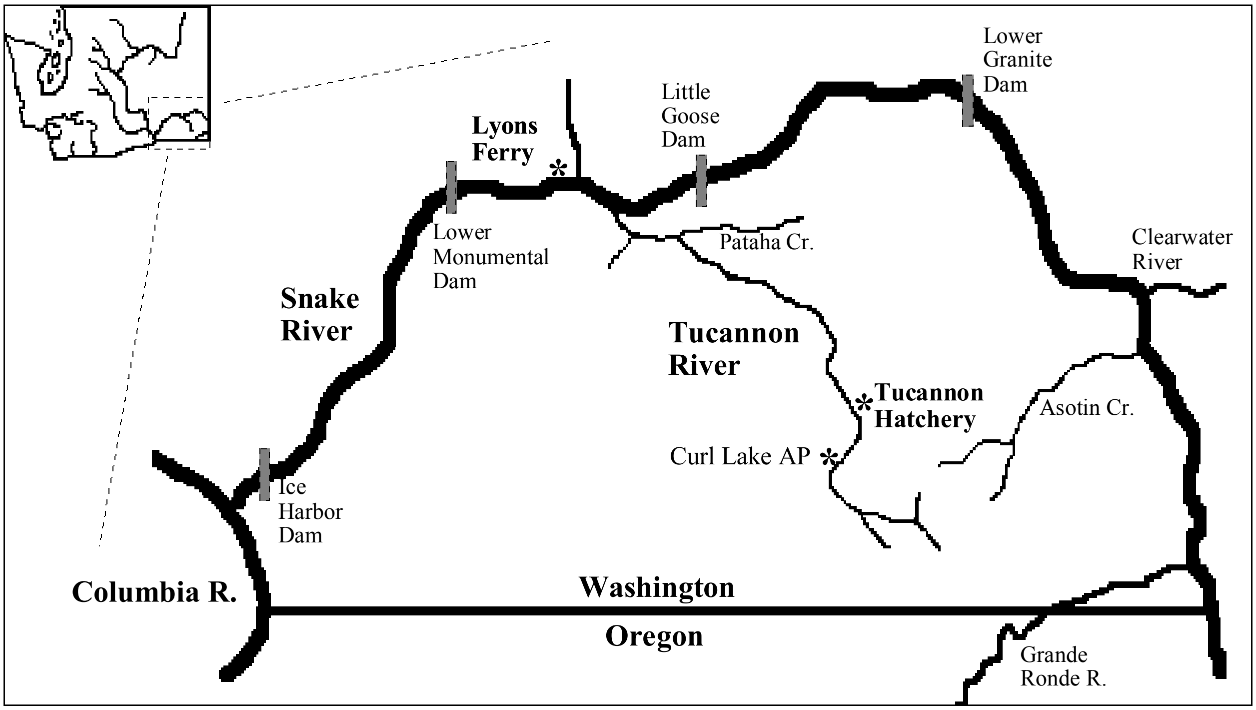

Figure 1. Location of the Tucannon River, Lyons Ferry, and Tucannon hatcheries within the Snake River Basin.

Table 1. Description of five strata within the Tucannon River.

Strata	Land Ownership/Usage	Spring Chinook Habitat	River Kilometer[a]
Lower	Private/Agriculture & Ranching	Not-Usable (temperature limited)	0.0-20.1
Marengo	Private/Agriculture & Ranching	Marginal (temperature limited)	20.1-39.9
Hartsock	Private/Agriculture & Ranching	Fair to Good	39.9-55.5
HMA	State & Forest Service/Recreational	Good/Excellent	55.5-74.5
Wilderness	Forest Service/Recreational	Excellent	74.5-86.3

[a] Rkm descriptions: 0.0–mouth at the Snake River; 20.1-Territorial Rd.; 39.9–Marengo Br.; 55.5-HMA Boundary Fence; 74.5-Panjab Br.; 86.3-Rucherts Camp.

Program staff deployed 19 continuous recording thermographs throughout the Tucannon River to monitor daily minimum and maximum water temperatures (temperatures are recorded every 1 to

1.2 hours) from May through October. Data from each of these water temperature recorders are kept on an electronic file in our Dayton office. During 2002, maximum temperatures near the mouth (rkm 3) of the Tucannon River reached 26.7 C (80 F) on 3 different days. Maximum temperatures where spring chinook juveniles were rearing during the hottest part of the summer ranged from 15.9 C (60.7 F) in the upper HMA stratum (rkm 74.5) to 23.1 C (73.6 F) in the lower Hartsock stratum (rkm 43.3)(Figure 2).

The upper lethal temperature for chinook fry is 25.1 C (77.2 F) while the preferred temperature range is 12-14 C (53.6-57.2 F) (Scott and Crossman 1973). The optimum range of temperature in freshwater, which controls the rate of growth and survival of young, is 13-17 C (55.4-62.6 F) (Becker 1983). Theurer et al. (1985) estimated that spring chinook production in the Tucannon River would be zero for all stream reaches having maximum daily July water temperatures greater than 23.9 C (75 F) (or average mean temperature of 20 C (68.0 F)). Based on the preferred and optimum temperature limits, fish returning to the upper watershed have the best chance for survival (Figure 2).

It is hoped that recent initiatives to improve habitat within the Tucannon Basin, such as the Tucannon River Model Watershed Program, will: 1) restore and maintain natural stream stability; 2) reduce water temperatures; 3) reduce upland erosion and sediment delivery rates; and 4) improve and re-establish riparian vegetation. Theurer et al. (1985) estimated that improving riparian cover and channel morphology in the Tucannon River mainstem would increase chinook-rearing capacity present in the early 1980s by a factor of 2.5. Habitat restoration efforts should permit increased utilization of habitat by spring chinook salmon in the marginal sections of the middle reaches of the Tucannon River and increase fish survival.

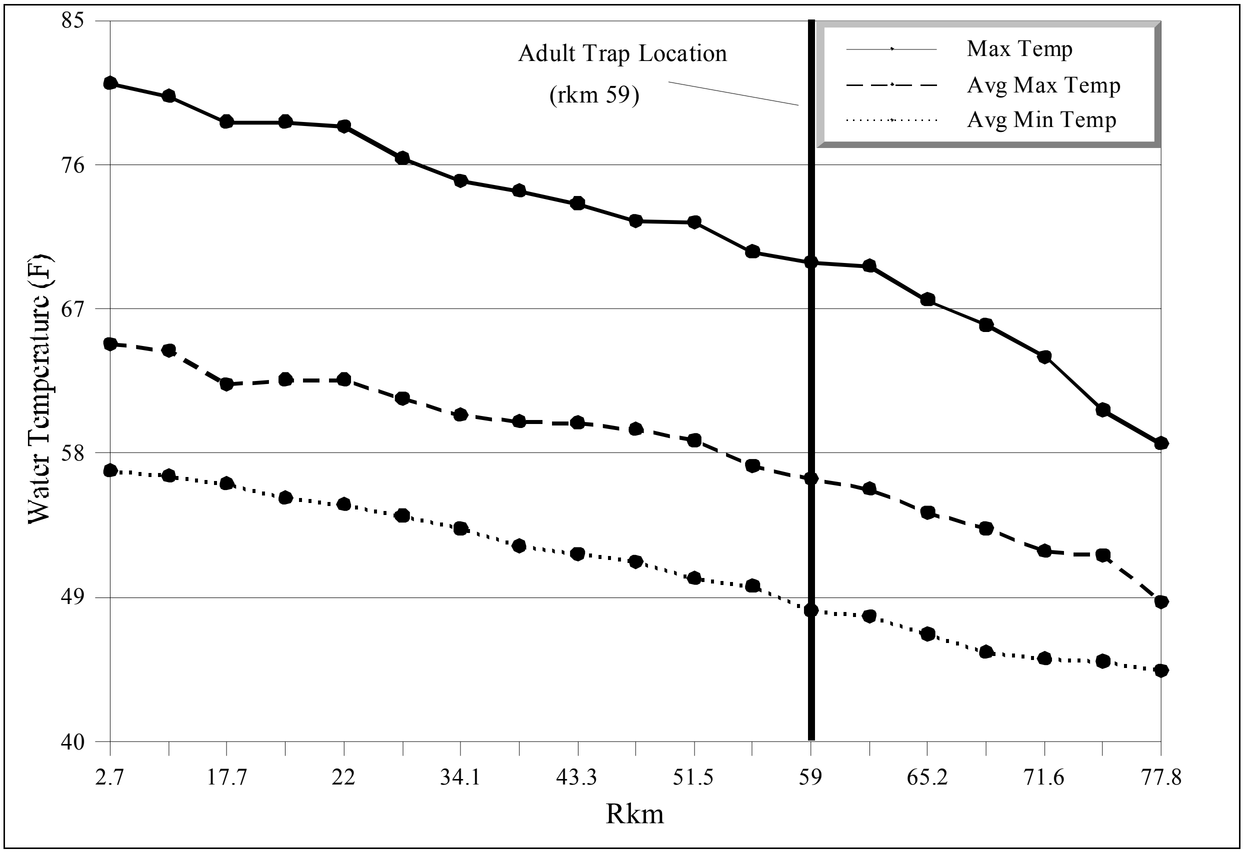

Figure 2. Maximum temperature, average maximum temperature, and average minimum temperature recorded by thermographs at 19 selected sites along the Tucannon River, May-October, 2002.

Adult Salmon Evaluation

Broodstock Trapping

The annual collection goal for broodstock is 50 natural and 50 hatchery adults collected throughout the duration of the run. Additional jack salmon may be collected to contribute to the broodstock if necessary. Jack contribution to the broodstock can be no more than their percentage in the overall run. Returning hatchery salmon were identified by lack of the adipose fin.

The TFH adult trap began operation in February (for steelhead) with the first spring chinook captured May 4. The trap was operated through September. A total of 778 fish entered the trap (166 natural adults, 2 natural jacks, 589 hatchery adults, and 21 hatchery jacks), and 107 were collected and hauled to LFH for broodstock (Table 2, Appendix A). Fish not collected for broodstock were passed upstream. Adults collected for broodstock were injected with erythromycin and oxytetracycline (0.5 cc/4.5 kg); jacks were given half dosages. Fish received formalin drip treatments during holding at 167 ppm every other day at LFH to control fungus.

Based on previous year returns, we anticipated catching unmarked Umatilla origin hatchery fish. We decided prior to broodstock trapping that scale samples would be collected from all unmarked fish for scale pattern analysis in the hope of identifying hatchery origin fish. Unmarked fish collected for broodstock were injected with a Passive Integrated Transponder (PIT) tag for individual identification. If scale analysis determined that a "wild" fish collected for broodstock was actually of hatchery origin, that fish would be identified by its PIT tag number and killed. Ten of the "wild" fish collected for broodstock were determined to be of hatchery origin and were killed to protect genetic integrity. These ten fish were ripe during the first spawn day, which tends to confirm our suspicions that they were from the Umatilla River as that stock spawns earlier than Tucannon origin fish. To ensure that we would reach our eggtake goal, four additional hatchery fish (visible AD clip) were collected at the adult trap during September.

Table 2. Numbers of spring chinook salmon captured, trap mortalities, fish collected for broodstock, or passed upstream to spawn naturally at the TFH trap from 1986-2002.

Year	Captured at Trap		Trap Mortality		Broodstock Collected		Passed Upstream	
	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery
1986	247	0	0	0	116	0	131	0
1987	209	0	0	0	101	0	108	0
1988	267	9	0	0	116	9	151	0
1989	156	102	0	0	67	102	89	0
1990	252	216	0	1	60	75	191	134
1991	109	202	0	0	41	89	68	105
1992	242	305	8	3	47	50	165	202
1993	191	257	0	0	50	47	130	167
1994	36	34	0	0	36	34	0	0
1995	10	33	0	0	10	33	0	0
1996	76	59	1	4	35	45	33	7
1997	99	160	0	0	43	54	47	76
1998 [a]	50	43	0	0	48	41	1	1
1999 [b]	1	139	0	1	1	135	0	0
2000 [c]	28	177	0	17	12	69	13	94
2001	405	276	0	0	52	54	353	222
2002	168	610	0	0	42	65	126	545

[a] Two males (one natural, one hatchery) captured were transported back downstream to spawn in the river.
[b] Three hatchery males that were captured were transported back downstream to spawn in the river.
[c] 17 stray LV and ADLV fish were killed at the trap.

Broodstock Mortality

Two of the 107 salmon collected for broodstock died prior to spawning in 2002 (Table 3). Table 3 shows that prespawning mortality in 2002 was comparable to the mortality documented since broodstock began being held at LFH in 1992. Higher mortality was experienced when fish were held at TFH (1986-1991).

Table 3. Numbers of prespawning mortalities and percent of fish collected for broodstock at TFH and held at TFH (1985-1991) or LFH (1992-2002).

Year	Natural			% of collected	Hatchery			% of collected
	Male	Female	Jack		Male	Female	Jack	
1985	3	10	0	59.1	—	—	—	—
1986	15	10	0	21.6	—	—	—	—
1987	10	8	0	17.8	—	—	—	—
1988	7	22	0	25.0	—	—	9	100.0
1989	8	3	1	17.9	5	8	22	34.3
1990	12	6	0	30.0	14	22	3	52.0
1991	0	0	1	2.4	8	17	32	64.0
1992	0	4	0	8.2	2	0	0	4.0
1993	1	2	0	6.0	2	1	0	6.4
1994	1	0	0	2.8	0	0	0	0.0
1995	1	0	0	10.0	0	0	3	9.1
1996	0	2	0	5.7	2	1	0	6.7
1997	0	4	0	9.3	2	2	0	7.4
1998	1	2	0	6.3	0	0	0	0.0
1999	0	0	0	0.0	3	1	1	3.8
2000	0	0	0	0.0	1	2	0	3.7
2001	0	0	0	0.0	0	0	0	0.0
2002	0	0	0	0.0	1	1	0	3.1

Broodstock Spawning

Spawning at LFH occurred once a week from August 27 to September 17, with peak eggtake on September 3. A total of 169,364 eggs were collected (Table 4). Eggs were initially disinfected and water hardened for one hour in iodophor (100 ppm). Fungus on the incubating eggs was controlled with formalin applied every-other day at 1,667 ppm for 15 minutes. Mortality to eye-up was 3.6% with an additional 7.2% (11,786) loss of sac-fry, which left 151,531 fish for production.

To prevent any stray fish from contributing to the population, all coded wire tags (CWT) were read prior to spawning. Two hatchery females were determined to be strays and were killed outright. Scales from unmarked fish were read prior to spawning to check for hatchery growth patterns. Carcasses were buried instead of being used for nutrient enhancement due to the detection of Infectious Hematopoietic Necrosis virus in the broodstock.

Table 4. Number of fish spawned, estimated egg collection, and egg mortality of Tucannon River spring chinook salmon at LFH in 2002.

Spawn Date	Natural			Hatchery		
	Male	Female	Eggs Taken	Male	Female	Eggs Taken

8/27	4[a]	3	10,858	4	4[b]	6,702
9/03	14[a]	6	26,264	6	13	43,004
9/10	4[a]	8	31,973	8	4	13,887
9/17	6[a]	5	17,021	8	6	19,655
Totals	**20**	**22**	**86,116**	**26**	**25**	**83,248**
Egg Mortality			2,041			4,006

[a] Denotes live spawned fish.
[b] Two of the four hatchery females were determined to be strays and their eggs were destroyed.

Eggs were also collected as part of the Tucannon River Captive Broodstock Program. Based on our projections, if all mature captive broodstock were spawned we would exceed our eggtake goal again as happened in 2001. To prevent having excess fish on hand, we decided to outplant excess mature captive broodstock in 2002. From the 1998 and 1999 brood years, we removed 21 and 76 fish respectively for outplanting in the Tucannon River (see Radio Tracking Section). All other mature captive brood fish were spawned from August 27 to October 2. A total of 121 captive brood females were spawned for a total eggtake of 176,544. Loss to eye-up was 68% leaving only 55,711 live eggs. Reasons for the high mortality are unknown but are most likely related to poor egg viability. An additional 5,249 dead eggs/fry were picked at ponding leaving only 50,462 fish for rearing. This is well below the program release goal (150,000 smolts) due to the higher than expected egg mortality. The Tucannon River Captive Broodstock Program was funded through the BPA and results achieved to date are more thoroughly described in the annual Tucannon River Spring Chinook Captive Broodstock Report (Gallinat and Varney 2003).

Radio Tracking

A spring chinook that was radio tagged (channel 11, code 92, frequency 149.52 MHz) by the University of Idaho at Bonneville Dam was tracked in the Tucannon River during 2002. This fish passed our smolt trap (rkm 2.7) on May 15. On May 29 the fish was detected just below the Tucannon Hatchery Adult Trap (rkm 59). It entered the adult trap on June 12 and was passed upstream by hatchery personnel. Efforts to locate this fish after it was passed upstream were unsuccessful. The radio tag either quit working or the fish/transmitter left the area.

On August 20, 97 (21 1998 BY and 76 1999 BY) excess Tucannon River captive brood adult spring chinook were released (Table 5) into the Tucannon River at Panjab Bridge (rkm 74.5). All released fish were Monel jaw tagged and radio transmitters were inserted into ten of the larger (presumably female) fish for tracking and monitoring in the wild. Radio tagged fish were monitored weekly through the end of September (Appendix B). Table 5 summarizes the tagging and recovery information from the radio tagged fish. Two of the radio tagged females spawned successfully within 2 km of the release site (9/165 and 9/192). Another female (9/167) that was attempting to spawn (actively digging a redd) died after releasing less than 10% of her eggs. Of the remaining seven fish: three tags were recovered hidden on the stream bank without a carcass and may have been illegally harvested; two fish were eaten by predators; one fish was a prespawn mortality unrecoverable in a debris jam; and one fish (9/203) was never located after release – the radio stopped transmitting or the fish and transmitter left the area.

Table 5. Radio tagging and recovery data for ten adult captive spring chinook salmon tagged on July 16 and released on August 20 at Panjab Bridge in the Tucannon River during 2002.

	Release Data			Recovery Data				
Channel/ Code	**Panjab Br. Rkm**	**Sex**	**FL (cm)**	**Recovery Information**	**Date**	**Rkm**	**Likely Poached**	**Spawned**
9/165	74.5	F	58.0	Recovered fish & tag	9/25	72.9	No	Yes
9/167	74.5	F	55.5	Recovered fish & tag	9/13	73.0	No	No
9/171	74.5	F	56.5	Recovered fish & tag	9/23	73.4	No	No
9/179	74.5	F	55.5	Tag found on bank	9/20	77.7	Yes	No
9/183	74.5	F	52.0	Tag found on bank	9/20	74.5	Yes	No
9/184	74.5	F	51.0	Carcass in log jam	--	68.7	No	No
9/192	74.5	F	50.0	Recovered fish & tag	9/27	73.6	No	Yes
9/193	74.5	F	51.0	Tag in animal den	--	73.5	No	No
9/203	74.5	F	49.0	Lost contact	--	--	??	??
9/205	74.5	F	47.0	Tag found on bank	9/13	76.6	Yes	No

Outplanted adults differed from wild and hatchery-origin fish in the river in morphology and coloration. Captive brood males lacked a prominent kype and captive fish were more golden-yellow in color. During redd surveys, released captive brood adults were observed being chased by more dominant male and female wild and hatchery-origin fish in the river.

In studies by Berejikian et al. (1997), wild coho females produced more nests than captive brood females. They also found that captive brood coho males were dominated by wild males and were also attacked more often by females. Fleming and Gross (1993) found coho hatchery females were delayed in spawning, retained more eggs, spawned in less desirable areas, and were less successful in guarding nest sites.

Losses to predation may be higher for fish released from a hatchery environment due to inappropriate avoidance and foraging behaviors and their inability to accurately assess predation risks, secondary stress effects, and a general unfamiliarity with their new surroundings (Steward and Bjornn 1990).

Due to the low frequency of natural spawning by released fish, high mortality due to predation and probable illegal harvest, and high egg mortality in the hatchery during 2002, priority will be to release excess progeny as parr to stay within smolt release goals rather than the release of excess captive broodstock as adults.

Natural Spawning

Spawning ground surveys were conducted on the Tucannon River weekly from August 22 to October 7, 2002 to count redds and determine the temporal and spatial distribution of spawners. Two hundred ninety-nine redds were counted and 79 natural and 121 hatchery origin carcasses were recovered (Table 6). One hundred ninety-seven redds (66% of total) and 140 carcasses (70% of total) were found above the adult trap. U.S. Forest Service personnel reported seeing 5 chinook redds with no fish associated with them near Ruchert's Camp (rkm 86.3) (Bill Dowdy, U.S. Forest Service, personal communication). These may have been bull trout redds due to their location and lack of carcasses and were not included in the totals.

Table 6. Numbers and general locations of salmon redds and carcasses recovered on the Tucannon River spawning grounds, 2002. (The Tucannon Hatchery adult trap is located at rkm 59.)				
			Carcasses Recovered	
Stratum	**Rkm**[a]	**Number of redds**	**Natural**	**Hatchery**
Wilderness	78-84	3	0	1
	75-78	10	0	3
HMA	73-75	46	10	19
	68-73	61	7	40
	66-68	22	2	8
	62-66	43	12	14
	59-62	12	10	14
	56-59	43	24	13
Hartsock	52-56	24	9	7
	47-52	12	3	0
	43-47	4	1	1
	40-43	6	1	0
Marengo	34-40	11	0	1
	28-34	2	0	0
Totals	28-84	299	79	121

[a] Rkm descriptions: 84-Sheep Cr.; 78-Lady Bug Flat CG; 75-Panjab Br.; 73-Cow Camp Bridge; 68-Tucannon CG; 66-Curl Lake; 62-Beaver/Watson Lakes Br.; 59-Tucannon Hatchery Intake/Adult Trap; 56-HMA Boundary Fence; 52-Br. 14; 47-Br. 12; 43-Br. 10; 40-Marengo Br.; 34-King Grade Br.; 28-Enrich Br.

Historical Trends

Two general trends were evident from the program's inception in 1985 through 1999:

1) The proportion of the total number of redds occurring below the trap increased; and
2) The density of redds (redds/km) decreased in the Tucannon River.

In part, this resulted from a greater emphasis on broodstock collection to keep the spring chinook population above extinction. However, increases in the SAR rates beginning with the 1995 brood have subsequently resulted in increased spawning above the trap and higher redd densities. The number of redds in 2002 increased 225% from 2000 levels and were the most recorded since surveys began in 1985 (Table 7).

Table 7. Number of spring chinook salmon redds and redds/km (in parenthesis) by stratum and year, and the

number and percent of redds above and below the TFH adult trap in the Tucannon River, 1985-2002.									
	Strata					**TFH Adult Trap**			
Year	**Wilderness**	**HMA**	**Hartsock**	**Marengo**	**Total Redds**	**Above**	**%**	**Below**	**%**
1985	97 (8.2)	122 (6.2)	–	–	219	–	–	–	–
1986	53 (4.5)	117 (6.2)	29 (1.9)	0 (0.0)	200	163	81.5	37	18.5
1987	15 (1.3)	140 (7.4)	30 (1.9)	–	185	149	80.5	36	19.5
1988	18 (1.5)	79 (4.2)	20 (1.3)	–	117	90	76.9	27	23.1
1989	29 (2.5)	54 (2.8)	23 (1.5)	–	106	74	69.8	32	30.2
1990	20 (1.7)	94 (4.9)	64 (4.1)	2 (0.3)	180	96	53.3	84	46.7
1991	3 (0.3)	67 (2.9)	18 (1.1)	2 (0.3)	90	40	44.4	50	55.6
1992	17 (1.4)	151 (7.9)	31 (2.0)	1 (0.2)	200	130	65.0	70	35.0
1993	34 (3.4)	123 (6.5)	34 (2.2)	1 (0.2)	192	131	68.2	61	31.8
1994	1 (0.1)	10 (0.5)	28 (1.8)	5 (0.9)	44	2	4.5	42	95.5
1995	0 (0.0)	2 (0.1)	3 (0.2)	0 (0.0)	5	0	0.0	5	100.0
1996	1 (0.1)	33 (1.7)	34 (2.2)	0 (0.0)	68	11	16.2	58	83.8
1997	2 (0.2)	43 (2.3)	27 (1.7)	1 (0.2)	73	30	41.1	43	58.9
1998	0 (0.0)	3 (0.2)	20 (1.3)	3 (0.5)	26	3	11.5	23	88.5
1999	1 (0.1)	34 (1.8)	6 (0.4)	0 (0.0)	41	3	7.3	38	92.7
2000	4 (0.4)	68 (3.6)	20 (1.3)	0 (0.0)	92	45	48.9	47	51.1
2001	24 (2.7)	189 (9.9)	84 (5.3)	1 (0.2)	298	168	56.4	130	43.6
2002	13 (1.4)	227 (11.9)	46 (2.9)	13 (1.1)	299	197	65.9	102	34.1
Note: – indicates the river was not surveyed in that section during that year.									

Genetic Sampling

No electrophoretic samples were collected from spring chinook recovered in the river or from the hatchery during spawning in 2002. We collected 192 DNA samples (opercle punches) from adult salmon (93 natural origin and 99 hatchery origin) and 207 samples from captive broodstock spawners. These samples were sent to the WDFW genetics lab in Olympia for analysis.

Age Composition, Length Comparisons, and Fecundity

One objective of the monitoring program is to track the age composition of each year's returning adults. This allows us to annually compare ages of natural and hatchery-reared fish, and to examine long-term trends and variability in age structure. Overall, hatchery origin fish return at a younger age than natural origin fish (Figure 3). This difference is likely due to smolt size-at-release (hatchery origin smolts are generally 25-30 mm greater in length than natural smolts).

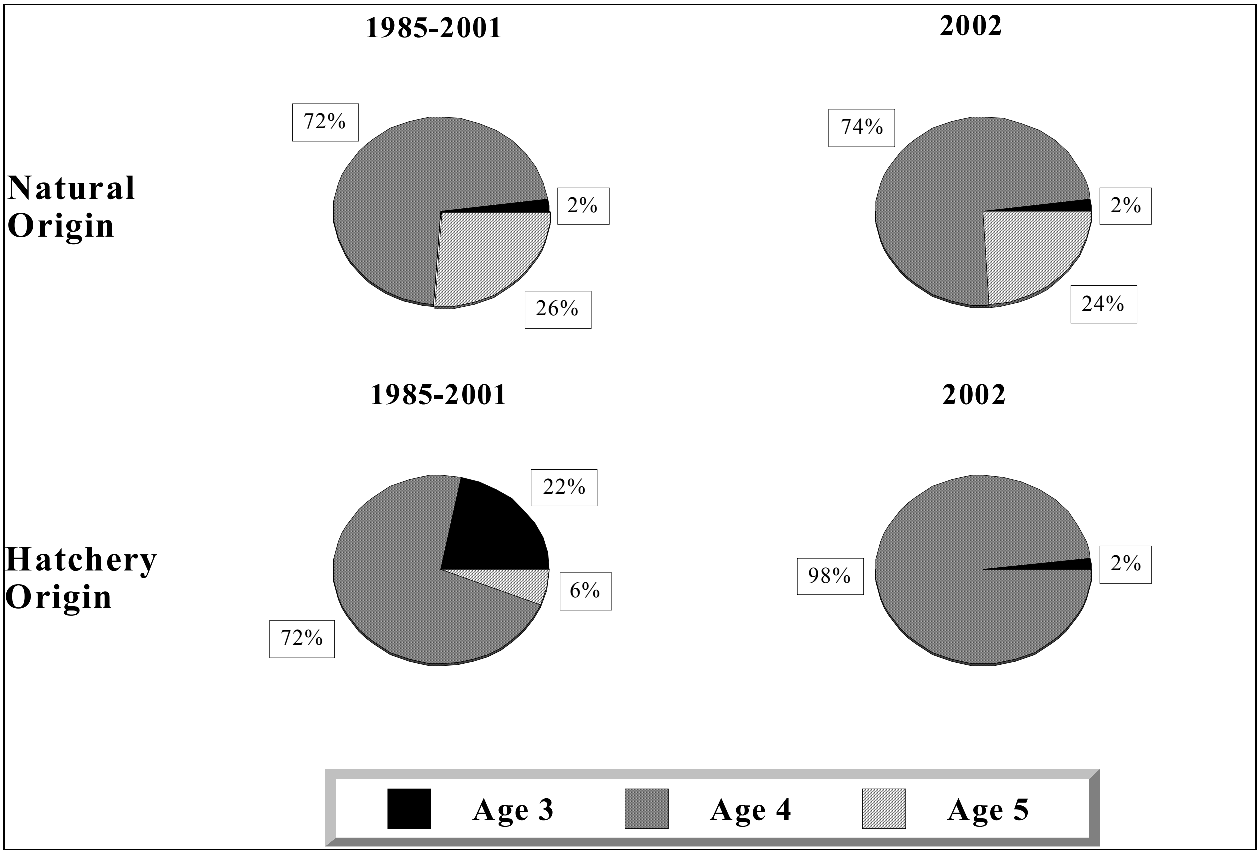

Figure 3. Historical (1985-2001), and 2002 age composition for spring chinook in the Tucannon River.

Age at return for natural origin fish during 2002 was very similar to historical runs. Hatchery fish were composed of more Age 4 fish than historically observed. Age 5 hatchery-origin fish were absent from the 2002 run but are expected to increase substantially during the 2003 run due to the large run of Age 4 fish in 2002 and desirable ocean conditions.

Another comparison we conduct on returning adult natural and hatchery origin fish is the difference between mean post-eye to hypural-plate lengths. We reported in the past (Bumgarner et al. 1994) that hatchery fish were generally shorter than natural origin fish of the same age. For many of the early return years this appeared to be true (Figures 4, 5, 6, and 7). However, overall for all combined return years, there is no difference in mean length between natural and hatchery origin fish, even though they migrate as smolts at significantly different sizes (Bugert et al. 1990; Bugert et al. 1991).

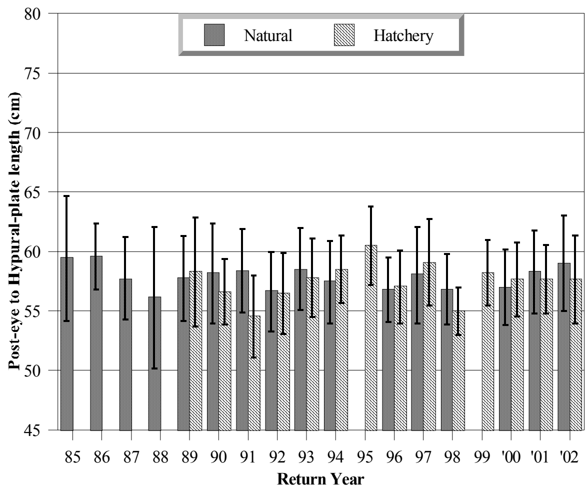

Figure 4. Mean length and SD of Age 4 females.

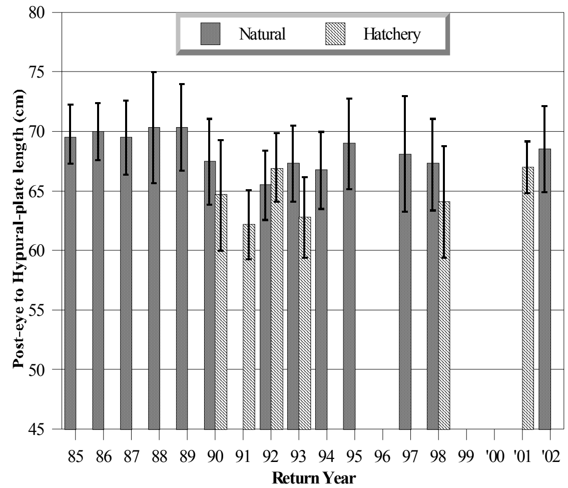

Figure 5. Mean length and SD of Age 5 females.

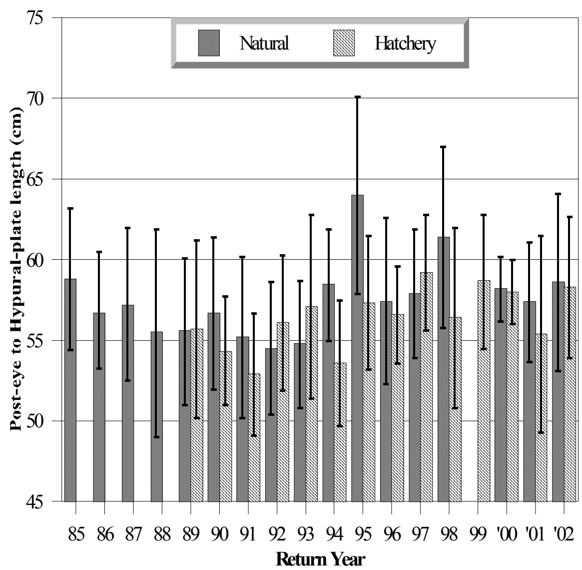

Figure 6. Mean length and SD of Age 4 males.

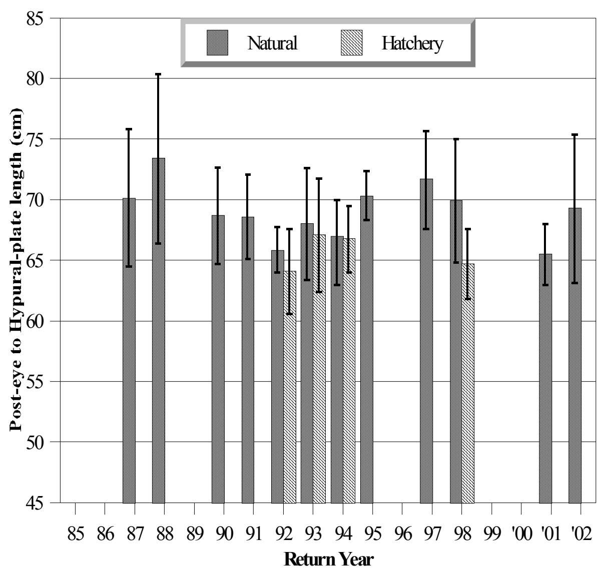

Figure 7. Mean length and SD of Age 5 males.

Fecundities (number of eggs/female) of natural and hatchery origin fish from the Tucannon River program have been documented since 1990 (Table 8). Analysis of variance was performed to determine if there were significant differences in mean fecundities at the 95% confidence level. Natural origin females had significantly higher fecundities than hatchery origin fish for both Age 4 ($P<0.001$) and 5-year-old fish ($P<0.001$).

Mean size of natural origin eggs in Age 4 spring chinook from the Tucannon River averaged 0.223 g/egg and hatchery origin eggs averaged 0.239 g/egg. This difference was statistically significant at the 95% confidence level ($P<0.05$). This may help explain why Age 4 hatchery origin females are less fecund. However, mean egg size in Age 5 salmon was 0.269 g/egg for natural origin and 0.270 g/egg for hatchery origin females, but the difference was not significant ($P= 0.95$).

Table 8. Average number of eggs/female (n, SD) by age group of Tucannon River natural and hatchery origin broodstock, 1990-2002.

Year	Age 4		Age 5	
	Natural	Hatchery	Natural	Hatchery
1990	3,691 (13, 577.3)	2,794 (18, 708.0)	4,383 (8, 772.4)	No Fish
1991	2,803 (5, 363.3)	2,463 (9, 600.8)	4,252 (11, 776.0)	3,052 (1, 000.0)
1992	3,691 (16, 588.3)	3,126 (25, 645.1)	4,734 (2, 992.8)	3,456 (1, 000.0)
1993	3,180 (4, 457.9)	3,456 (5, 615.4)	4,470 (1, 000.0)	4,129 (1, 000.0)
1994	3,688 (13, 733.9)	3,280 (11, 630.3)	4,906 (9, 902.0)	3,352 (10, 705.9)
1995	No Fish	3,584 (14, 766.4)	5,284 (6, 136.1)	3,889 (1, 000.0)
1996	3,509 (17, 534.3)	2,833 (18, 502.3)	3,617 (1, 000.0)	No Fish
1997	3,487 (15, 443.1)	3,290 (24, 923.3)	4,326 (3, 290.9)	No Fish
1998	4,204 (1, 000.0)	2,779 (7, 375.4)	4,017 (28, 680.5)	3,333 (6, 585.2)
1999	No Fish	3,121 (34, 445.4)	No Fish	3,850 (1, 000.0)
2000	4,144 (2, 1,111.0)	3,320 (34, 545.4)	3,618 (1, 000.0)	4,208 (1, 000.0)
2001	3,612 (27, 508.4)	3,225 (24, 690.6)	No Fish	3,585 (2, 842.5)
2002	3,584 (14, 740.7)	3,368 (24, 563.7)	4,774 (7, 429.1)	No Fish
Mean	3,596	3,185	4,376	3,474
SD	591.0	662.9	845.4	638.4

Coded-Wire Tag Sampling

Broodstock collection, pre-spawn mortalities, and carcasses recovered from spawning ground surveys provide representatives of the annual run that can be sampled for CWT study groups (Table 9). Stray fish were predominately from the Umatilla River, Oregon and are discussed in more detail in a later section of this report. In 2002, based on the estimated escapement of fish to the river, we sampled approximately 31% of the run (Table 10).

Table 9. Coded-wire tag codes of hatchery salmon sampled at LFH and the Tucannon River, 2002.

CWT Code	Broodstock Collected: Died in Pond	Killed Outright	Spawned	Recovered in Tucannon River: Dead in Trap	Pre-spawn Mortality	Spawned	Totals
63-12-11	2		47		1	104	154
63-02-75			2				2
-Strays-							
10-54-12						1	1
07-61-38						1	1
07-60-51						1	1
07-60-49						1	1
07-60-41						2	2
07-60-40			1			1	2
07-60-39			1				1
05-42-08						1	1
Lost tags						2	2
No tags		10[a]	2			6	18
Total	2	10	53	0	1	120	186

[a] Unmarked fish with hatchery-origin scale pattern - probable Umatilla River origin fish.

Table 10. Spring chinook salmon (natural and hatchery) sampled from the Tucannon River, 2002.

	2002 Natural	2002 Hatchery	2002 Total
Total escapement to river	350	655	1,005
Broodstock collected	42	65	107
Fish dead in adult trap	0	0	0
Total hatchery sample	42	65	107
Total fish left in river	308	590	898
In-river prespawn mortality	0	1	1
Spawned carcasses recovered	81	120	201
Total river sample	81	121	202
Carcasses sampled	123	186	309

Arrival and Spawn Timing Trends

Peak arrival and spawn timing have always been monitored to determine whether the hatchery program has caused a shift (Table 11). Peak arrival dates were based on greatest number of fish trapped on a single day. Peak spawn in the hatchery was determined by the day when the most females were spawned. Peak spawning in the river was determined by the highest weekly redd count.

Peak arrival during 2002 was at the average historical date for natural fish and earlier for hatchery fish as compared to previous years, but within the expected range compared to peak arrival before hatchery influence (1986-1988). Peak spawning date of hatchery fish in 2002 was also earlier than in previous years, although within the range found from previous years. The duration of active spawning in the Tucannon River was a week longer than previous years but that may be due in part to the larger run size.

Table 11. Peak dates of arrival of natural and hatchery salmon to the TFH adult trap and peak (date) and duration (number of days) for spawning in the hatchery and river, 1986-2002.

	Peak Arrival at Trap		Spawning in Hatchery			Spawning in River	
Year	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Duration**	**Combined**	**Duration**
1986	5/27	–	9/17	–	31	9/16	36
1987	5/15	–	9/15	–	29	9/23	35
1988	5/24	–	9/07	–	22	9/17	35
1989	6/06	6/12	9/15	9/12	29	9/13	36
1990	5/22	5/23	9/04	9/11	36	9/12	42
1991	6/11	6/04	9/10	9/10	29	9/18	35
1992	5/18	5/21	9/15	9/08	28	9/09	44
1993	5/31	5/27	9/13	9/07	30	9/08	52
1994	5/25	5/27	9/13	9/13	22	9/15	29
1995[a]	–	6/08	9/13	9/13	30	9/12	21
1996	6/06	6/20	9/17	9/10	21	9/18	35
1997	6/15	6/17	9/09	9/16	30	9/17	50
1998	6/03	6/16	9/08	9/16	36	9/17	16
1999[a]	–	6/16	9/07	9/14	22	9/16	23
2000	6/06	5/22	–	9/05	22	9/13	30
2001	5/23	5/23	9/11	9/04	20	9/12	35
Mean	**5/30**	**6/04**	**9/12**	**9/11**	**27**	**9/15**	**35**
2002	5/29	5/29	9/10	9/03	22	9/11	42

[a] Too few natural salmon were trapped in 1995 and 1999 to determine peak arrival.

Total Run-Size

In general, redd counts have been directly related to total run-size entering the Tucannon River and passage of adult salmon at the TFH adult trap (Bugert et al. 1991). For 2002, we used sex ratios from collected broodstock and sex ratio observations on the spawning grounds to estimate the number of fish/redd. The run-size estimate for 2002 was calculated by adding the estimated number of fish upstream of the TFH adult trap, the estimated fish below the weir based on an estimated fish/redd ratio, the number of pre-spawn mortalities below the weir, and the number of broodstock collected (Table 12). Total run-size for 2002 was estimated at 1,005 fish (341 wild adults, 9 wild jacks and 644 hatchery-origin adults, 11 hatchery jacks). The total run for jacks and adults by origin has been estimated since 1985 (Appendix C).

Table 12. Estimated spring chinook salmon run to the Tucannon River, 1985-2002.

Year[a]	Total Redds	Fish/Redd Ratio[b]	Spawning fish In the river	Broodstock Collected	Pre-spawning Mortalities[c]	Total Run-Size	Percent Natural
1985	219	2.60	569	22	0	591	100
1986	200	2.60	520	116	0	636	100
1987	185	2.60	481	101	0	582	100
1988	117	2.60	304	125	0	429	96
1989	106	2.60	276	169	0	445	76
1990	180	3.39	611	135	8	754	66
1991	90	4.33	390	130	8	528	49
1992	200	2.82	564	97	92	753	56
1993	192	2.27	436	97	56	589	54
1994	44	1.59	70	70	0	140	70
1995	5	2.20	11	43	0	54	39
1996	68	2.00	136	80	16	232	63
1997	73	2.00	146	97	45	288	47
1998	26	1.94	51	89	4	144	59
1999	41	2.60	107	136	2	245	1
2000	92	2.60	239	81	19	339	24
2001	298	3.00	894	106	12	1,012	71
2002	299	3.00	897	107	1	1,005	35

[a] In 1994, 1995, 1998 and 1999, fish were not passed upstream, and in 1996 and 1997, high pre-spawning mortality occurred in fish passed above the trap, therefore; fish/redd ratio was based on the sex ratio of broodstock collected.
[b] From 1985-1989 the TFH trap was temporary, thereby underestimating total fish passed upstream of the trap. The 1985-1989 fish/redd ratios were calculated from the 1990-1993 average, excluding 1991 because of a large jack run.
[c] Effort in looking for pre-spawn mortalities has varied from year to year with more effort expended during years with poor conditions.

Stray Salmon into the Tucannon River

Spring chinook from other river systems (strays) have periodically been recovered in the Tucannon River, though generally at a low proportion of the total run (Bumgarner et al. 2000). Through 1998 the incidence of stray spring chinook salmon was negligible (Table 13). However, in 1999, Umatilla River strays accounted for 8% of the total Tucannon River run, and that rate increased to 12% in 2000. The increase in the number of strays, particularly from the Umatilla River, is a concern since it exceeds the allowable 5% stray rate of hatchery fish as deemed acceptable by NOAA Fisheries (formerly NMFS) and is contrary to WDFW management intent for the Tucannon River. Beginning with the 1997 brood year releases, the Oregon Department of Fish and Wildlife (ODFW) and Confederated Tribes of the Umatilla Indian Reservation (CTUIR) ceased marking a portion of Umatilla River origin spring chinook with an RV or LV fin clip (65-70% of releases). Because of this action, fish that returned in 2002 were indistinguishable from wild origin spring chinook from the Tucannon River. For 2002, scale samples were collected from all wild fish collected for broodstock and passed upstream at the adult trap. Ten of the fish collected for broodstock (19%) were determined to be of hatchery origin, based on scale pattern analysis, and were destroyed. Twelve of the unmarked fish sampled and passed upstream were found to be of hatchery origin (12%) based on scale pattern analysis. Beginning with the 2000 BY, Umatilla River hatchery-origin spring chinook will be 100% marked. This will help ensure that Tucannon River spring chinook genetic integrity is maintained.

Table 13. Summary of identified stray hatchery origin spring chinook salmon that escaped into the Tucannon River (1990-2002).

Year	CWT Code or Fin clip	Agency	Origin (stock)	Release Location / Release River	Number Observed/ Expanded [a]	% of Tuc. Run
1990	074327	ODFW	Carson (Wash.)	Meacham Cr. / Umatilla River	2 / 5	
	074020	ODFW	Rapid River	Lookingglass Cr. / Grande Ronde	1 / 2	
	232227	NMFS	Mixed Col.	Columbia River / McNary Dam	2 / 5	
	232228	NMFS	Mixed Col.	Columbia River / McNary Dam	1 / 2	
				Total Strays	**14**	**1.9**
				Total Umatilla River	**5**	**0.7**
1992	075107	ODFW	Lookingglass Cr.	Bonifer Pond / Columbia River	2 / 6	
	075111	ODFW	Lookingglass Cr.	Meacham Cr. / Umatilla River	1 / 2	
	075063	ODFW	Lookingglass Cr.	Meacham Cr. / Umatilla River	1 / 2	
				Total Strays	**10**	**1.3**
				Total Umatilla River	**4**	**0.5**
1993	075110	ODFW	Lookingglass Cr.	Meacham Cr. / Umatilla River	1 / 2	
				Total Strays	**2**	**0.3**
				Total Umatilla River	**2**	**0.3**
1996	070251	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	1 / 1	
	LV clip	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	1 / 2	
				Total Strays	**3**	**1.2**
				Total Umatilla River	**3**	**1.2**
1997	103042	IDFG	South Fork Salmon	Knox Bridge / South Fork Salmon	1 / 2	
	103518	IDFG	Powell	Powell Rearing Ponds / Lochsa R.	1 / 2	
	RV clip	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	3 / 5	
				Total Strays	**9**	**2.6**
				Total Umatilla River	**5**	**1.4**
1999	091751	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	2 / 3	
	092258	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	1 / 1	
	104626	UI	Eagle Creek NFH	Eagle Creek NFH / Clackamas R.	1 / 1	
	LV clip	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	2 / 2	
	RV clip	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	8 / 13	
				Total Strays	**20**	**8.2**
				Total Umatilla River	**19**	**7.8**

[a] All CWT codes recovered from groups that were 100% marked were given a 1:1 expansion rate. Groups that were not 100% marked were expanded based on the percentage of unmarked fish. The expansion is based on the percent of stray carcasses to Tucannon River origin carcasses and the estimated total run in the river.

Table 13 (continued). Summary of identified stray hatchery origin spring chinook salmon that escaped into the Tucannon River (1990-2002).

Year	CWT Code or Fin clip	Agency	Origin (stock)	Release Location / Release River	Number Observed/ Expanded [a]	% of Tuc. Run
2000	092259	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	4 / 4	
	092260	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	1 / 1	
	092262	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	1 / 3	
	105137	IDFG	Powell	Walton Creek/ Lochsa R.	1 / 3	
	636330	WDFW	Klickitat (Wash.)	Klickitat Hatchery	1 / 1	
	636321	WDFW	Lyons Ferry (Wash.)	Lyons Ferry / Snake River	1 / 1	
	LV clip	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	18 / 31	
	No Ad	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	2 / 2	
				Total Strays	**46**	**13.6**
				Total Umatilla River	**41**	**12.1**
2001	076040	ODFW	Umatilla R.	Umatilla Hatch. /Umatilla River	1/7	
	092828	ODFW	Imnaha R. & Tribs.	Lookinglass/Imnaha River	1/3	
	092829	ODFW	Imnaha R. & Tribs.	Lookinglass/Imnaha River	1/3	
				Total Strays	**13**	**1.3**
				Total Umatilla River	**7**	**0.7**
2002	054208	USFWS	Dworshak	Dworshak NFH/Clearwater	1/29	
	076039	ODFW	Umatilla R.	River	1/8	
	076040	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	2/16	
	076041	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	2/16	
	076049	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/8	
	076051	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/8	
	076138	ODFW	Umatilla R.	Umatilla Hatch../ Umatilla River	1/8	
	105412	IDFG	Powell	Umatilla Hatch./Umatilla River	1/4	
				Clearwater Hatch./Powell Ponds	**97**	**9.6**
				Total Strays	**64**	**6.3**
				Total Umatilla River		

[a] All CWT codes recovered from groups that were 100% marked were given a 1:1 expansion rate. Groups that were not 100% marked were expanded based on the percentage of unmarked fish. The expansion is based on the percent of stray carcasses to Tucannon River origin carcasses and the estimated total run in the river.

Juvenile Salmon Evaluation

Hatchery Rearing, Marking, and Release

Hatchery Rearing and Marking

Based on recommendations by Gallinat et al. (2001), the adipose clip was abandoned for Tucannon River spring chinook to prevent harvest of this listed population in sport fisheries. Supplementation juveniles (2001 BY) were marked with a red elastomer tag (VIE) behind the right eye and tagged with CWTs on September 17-30, 2002 (149,273 fish). Supplementation fish were transported to TFH on October 10. The 2001 BY captive brood juveniles (144,492 fish) were marked on September 9-13 with an agency-only wire tag in the snout and transported to TFH on October 11.
Length and weight samples were collected three times on the 2001 BY fish during the rearing cycle (Table 14). During February, fish were sampled for length, weight, hatchery mark quality, and PIT tagged for outmigration comparisons (1,010 supplementation fish and 1,007 captive brood progeny) before transfer to Curl Lake.

Table 14. Summary of sample sizes (N), mean lengths (mm), coefficients of variation (CV), condition factors (K), and fish/lb (fpp) of 2001 BY juveniles sampled at LFH, TFH, and Curl Lake.

Brood/ Date	Progeny Type	Sample Location	N	Mean Length	CV	K	FPP
2001							
5/03/02	Supplementation	LFH	200	69.0	6.6	1.11	123.4
2/14/03	Supplementation	TFH	250	125.5	15.5	1.19	18.2
4/08/03	Supplementation	Curl Lake	250	139.4	16.3	1.21	12.9
5/03/02	Captive Brood	LFH	200	62.5	9.7	1.09	165.0
2/18/03	Captive Brood	TFH	250	116.5	12.7	1.19	23.3
4/08/03	Captive Brood	Curl Lake	250	135.3	17.2	1.21	13.9

2001 Brood Release

A total of 21,043 marked (AD clip/CWT) excess supplementation parr (123 fish/lb) and 20,592 marked (AD clip/CWT) excess captive brood progeny (165 fish/lb) were released on May 6 at Bridge 11 (rkm 44) on the Tucannon River (Table 15). This parr release allowed WDFW to stay within the maximum allowed number of smolts released under Section 10 Permit #1129 (150,000 supplementation, 150,000 captive brood progeny). The 2001 BY pre-smolts were transported to Curl Lake in February 2003 for acclimation and volitional release.

Volitional release began April 1 and continued until April 21 when remaining fish were forced out. Mortalities were low in Curl Lake and WDFW released an estimated 146,922 supplementation fish (12.9 fish/lb) and 140,396 captive broodstock progeny (13.9 fish/lb).

Table 15. Summary of parr and yearling spring chinook releases in the Tucannon River, 2001 brood year.

Release Year	(BY)	Release Location	Release Date	CWT Code	Number CWT	AD-only marked	Additional mark/cross	lbs	Fish/ lb
2002	(01)	Bridge 11	5/06	63/14/29	19,948	1,095	No VI, Mixed	170.5	123.4
2002	(01CB)	Bridge 11	5/06	63/14/30	20,435	157	No VI, Mixed	124.8	165.0
2003		Curl Lake	4/01-4/21	63/06/81	146,922	N/A	Rt. Red VI, Mixed	11,389	12.9
2003	(01) (01CB)	Curl Lake	4/01-4/21	63	140,396	N/A	No VI, Mixed	10,100	13.9

N/A = Not applicable.

Natural Parr Production

Program staff surveyed the Tucannon River at index sites in 2002 to estimate the density and population of subyearling (Table 16, Appendix D) and yearling spring chinook salmon. Snorkel surveys were conducted using a total count method (Griffith 1981, Schill and Griffith 1984). Population size was determined by multiplying the mean fish density (fish/100 m^2) by the estimated total area within each stratum. Fifty sites were snorkeled in 2002 (August 12–13). Total area snorkeled was approximately 5.0% of the suitable rearing habitat in the Tucannon River. A total of 3,017 subyearling and 35 yearling spring chinook were counted during the surveys. We estimated that 63,412 (± 11,733) subyearling and 703 (± 374) yearling chinook were present in the river (Table 16).

Table 16. Number of sites, area snorkeled, mean density (fish/100 m^2), population estimates, and 95% confidence intervals for subyearling and yearling spring chinook within the Tucannon River, 2002.

			Subyearling			Yearling		
Stratum	Number of sites	Area (m^2) snorkeled	Mean Density	Pop. Estimate	C.I.	Mean Density	Pop. Estimate	C.I.
Marengo	6	2,973	9.79	5,625	2,823	0.04	23	44
Hartsock	14	7,921	14.01	24,735	6,864	0.04	68	76
HMA	20	11,771	12.60	28,175	7,926	0.16	350	283
Wilderness	10	4,155	6.05	4,877	4,503	0.32	262	198
Total	50	26,820	11.35	63,412	11,733	0.14	703	374

Natural Smolt Production

Program staff operated a 1.5 m rotary screw trap at rkm 3 on the Tucannon River from October 14, 2001 to July 15, 2002 to estimate numbers of migrating natural and hatchery spring chinook. The smolt trap was pulled from October 23-January 22 to convert the smolt trap drum cleaning system to a paddle wheel drive design. The trap was pulled again from April 6-10 to fix a hole in the cone. Other data on natural and hatchery spring chinook smolts such as peak outmigration, length of smolts, etc., have not been reported here for simplicity. Those data are available upon request.

We examined the influence of specific abiotic variables on spring chinook emigration during the last five trapping seasons (1997/1998 to 2001/2002) using correlation analysis. Significant relationships were found between the total number of wild spring chinook smolts captured ($\log_{10}$ transformed for normality) emigrating from the Tucannon River and flow (ft^3 /sec) ($r^2 = 0.26$, $P < 0.01$), staff gauge level ($r^2 = 0.21$, $P < 0.01$), time of year ($r^2 = 0.27$, $P < 0.01$), water temperature ($r^2 = 0.24$, $P < 0.01$), and secchi reading ($r^2 = 0.28$, $P < 0.01$). Although these variables are statistically significant, they account for only a small amount of the variability in the number of emigrating fish. This is understandable as smoltification is a physiological process and the resulting outmigration may only be slightly influenced by abiotic factors. No significant relationships were found between the numbers of hatchery spring chinook smolts captured ($\log_{10}$ transformed) and flow, staff gauge level, time of year, water temperature, or secchi disk reading.

Each week we attempted to determine trap efficiency by clipping a portion of the caudal fin on a few representative captured migrants and releasing them one kilometer upstream. The percent of marked fish recaptured was used as an estimate of weekly trapping efficiency. To calculate trapping efficiency during weeks when low numbers of fish were caught we examined the relationship between trap efficiency and the variables flow, staff gauge, number of fish captured, water temperature, and time of year (week). There were no statistically significant relationships between trap efficiency for wild and hatchery spring chinook and any of the variables examined. Despite the low statistical power, we believe that trap efficiency decreases as flow increases.

Flow is the dominant factor affecting downstream migrant trapping operations in any system according to Seiler et al. (1999). Groot and Margolis (1991) state that the rate of downstream migration of chinook fingerlings appears to be both time and size dependent and may also be related to river discharge and the location of fish in the river. They state that during years of low and stable river flow; the rate of downstream migration was negatively correlated with discharge, whereas, when flows were higher and more variable, the rate of migration was positively correlated with discharge.

Mean daily flow data was provided by the U.S. Geological Survey gauge station at Starbuck, WA (rkm 12.7). Correlation analysis indicated a statistically significant relationship between flow and the staff gauge level at the smolt trap at the 99% confidence level ($r^2 = 0.85$). As the U.S.G.S. flow data is computer monitored on a continuous basis and is in relatively close proximity to the smolt trap, we estimated trap efficiencies based on the U.S.G.S. flow data with the following equations:

<u>Wild Spring Chinook</u>
Trap Efficiency = 22.48 - 0.01 (Flow)

<u>Hatchery Spring Chinook</u>
Trap Efficiency = 22.09 - 0.04 (Flow)

To estimate potential juvenile migrants passing when the trap was not operated for short intervals, such as periods when freshets washed out large amounts of debris from the river, we calculated the average number of fish trapped for three days before and three days after non-trapping periods. The mean number of fish trapped daily was then divided by the estimated trap efficiency to calculate fish passage. The estimated number of fish passing each day was then applied to each day the trap was not operated.

During the October 23 – January 22 time period when the smolt trap was being modified the number of wild spring chinook that would have been captured was predicted by an exponential model based on the 2000 and 2001 smolt trapping data using the following equation:

Number of wild spring chinook = exp [0.114 + 0.014 (Flow)] ($r^2 = 0.47$; $P < 0.01$)

We estimated that 20,049, or 45% of the 2000 BY parr estimates, passed the smolt trap during 2001-2002 (Table 17). We also estimated that 90% of the hatchery supplementation fish and 32% of the captive brood progeny released from Curl Lake Acclimation Pond (2000 BY) passed the smolt trap.

Table 17. Monthly and total population estimates, with 95% confidence intervals, for natural and hatchery origin (supplementation and captive brood) emigrants from the Tucannon River, 2002.

Month	Natural	+/- 95% C.I.	Hatchery	+/- 95% C.I.	C.B.[b]	+/- 95% C.I.
Sept.-Feb.	496	26	0	--	0	--
March	367	27	0	--	0	--
April	11,375	884	13,957	2,819	266	44
May	7,753	533	77,949	8,345	697	104
June	58	10	301	32	0	0
Total	20,049	1,480	92,207	11,196	963	148
% Survival[a]	44.9		90.3		31.5	

[a] Percent survival to smolt based on estimated number of parr from summer snorkel surveys (natural origin) or from TFH release numbers (hatchery origin).
[b] C.B. = captive brood progeny.

Juvenile Migration Studies

In 2002, WDFW used Passive Integrated Transponder (PIT) tags to study the emigration timing and success of wild and hatchery origin spring chinook. The tags allowed us to identify the characteristics of successful smolts. We tagged 321 wild and 318-hatchery origin spring chinook over a two-week period (Table 18). No fish were killed during PIT tagging, though it is likely that some delayed mortality occurred after release. Detection rates were generally higher for wild chinook and mean travel days were generally higher for hatchery spring chinook. Detection rates may be higher for wild chinook because they are smaller (25-48 mm less) and more likely to be captured at collection facilities, or survival rates were actually slightly higher.

Table 18. Cumulative detection (one unique detection per tag code) and travel time (TD) summaries of PIT tagged spring chinook salmon released from the Tucannon River smolt trap (rkm 3) at downstream Snake and Columbia River dams in 2002.

Release Data				Recapture Data									
					LMJ		MCJ		JDJ		BONN		Total
Release Date	Origin	N	Mean Length	Mean Length	N	TD	N	TD	N	TD	N	TD	N (%)
4/29-02	W	220	105.5	105.6	93	3.8	41	10.1	18	14.1	7	18.9	159 (72.3)
	H	219	138.2	139.8	77	5.4	28	11.6	12	16.4	6	22.1	123 (56.2)
5/06-08	W	101	105.3	105.0	31	3.3	21	8.9	6	14.1	4	15.4	62 (61.4)
	H	99	138.0	136.5	29	5.2	24	10.3	5	14.7	4	15.5	62 (62.6)

Note: Mean travel times listed are from the total number of fish detected at each dam, not just unique recoveries for a tag code. Abbreviations are as follows: LMJ-Lower Monumental Dam, MCJ- McNary Dam, JDJ-John Day Dam, BONN-Bonneville Dam, TD- Mean Travel Days.

Survival probabilities were estimated by the Cormack Jolly-Seber methodology using the Survival Under Proportional Hazards (SURPH2) computer model. The data files were created using the CAPTHIST program. Data for input into CAPHIST was obtained directly from PTAGIS. Survival estimates to Lower Monumental Dam were 0.94 (± 0.06) and 0.83 (± 0.07) for wild and hatchery-origin fish, respectively. While survival estimates were slightly lower for hatchery-origin fish the differences were not significant. Survival estimates to John Day Dam were nearly identical at 0.67 (± 0.15) for wild and 0.66 (± 0.25) for hatchery-origin fish.

Survival Rates

Point estimates of population sizes have been calculated for various life stages (Tables 19 and 20) of natural origin fish from spawning ground and juvenile mid-summer population surveys, smolt trapping, and fecundity estimates. From these two tables, survivals between life stages have been calculated for both natural and hatchery salmon to assist in the evaluation of the hatchery program. These survival estimates provide insight as to where efforts should be directed to improve not only the survival of fish produced within the hatchery, but fish in the river as well.

As expected, juvenile (egg-fry-smolt) survival rates for hatchery fish are considerably higher than for naturally reared salmon (Table 21) because they have been protected in the hatchery. However, smolt-to-adult return rates (SAR) of natural salmon were about three times higher than for hatchery-reared salmon (Tables 22 and 23). The mean hatchery SAR's (0.15%) documented from the 1985-1997 broods were below the goal SAR of 0.87% established under the LSRCP. Hatchery SAR's for Tucannon River salmon need to substantially improve to meet the mitigation goal of 1,152 salmon.

Table 19. Estimates of *natural* Tucannon spring chinook salmon abundance by life stage for 1985-2002 broods.

Brood Year	Females in river: natural	Females in river: hatchery	Mean[a] fecundity: natural	Mean[a] fecundity: hatchery	Number of eggs	Number[b] of fry	Number of smolts	Progeny[c] (returning adults)
1985	219	-	3,883	-	850,377	90,200	42,000	392
1986	200	-	3,916	-	783,200	102,600	58,200	468
1987	185	-	4,096	-	757,760	79,100	44,000	238
1988	117	-	3,882	-	454,194	69,100	37,500	527
1989	103	3	3,883	2,606	407,767	58,600	30,000	158
1990	128	52	3,993	2,697	651,348	86,259	49,500	94
1991	51	39	3,741	2,517	288,954	54,800	30,000	7
1992	119	81	3,854	3,295	725,521	103,292	50,800	194
1993	112	80	3,701	3,237	673,472	86,755	49,560	204
1994	39	5	4,187	3,314	179,863	12,720	7,000	12
1995	5	0	5,224	0	26,120	0	75	6
1996	53	16	3,516	2,843	231,836	2,845	1,612	69
1997	39	33	3,609	3,315	250,146	32,913	21,057	803
1998	19	7	4,023	3,035	97,682	8,453	5,508	266
1999	1	40	3,965	3,142	129,645	15,944	8,157	9
2000	26	66	3,969	3,345	323,964	44,618	20,045	
2001	219	79	3,612	3,252	1,047,936	63,412		
2002	104	195	3,981	3,368	1,070,784			

a 1985 and 1989 mean fecundity of natural females is average of 1986-88 and 1990-93.
b Number of fry estimated from electrofishing (1985-1989), Line transect snorkel surveys (1990-1992), and Total Count snorkel surveys (1993-1999).
c Numbers do not include down river harvest estimates or out-of-basin recoveries.

Table 20. Estimates of Tucannon spring chinook salmon abundance (*spawned and reared in the hatchery*) by life stage for 1985-2002 broods.

Brood Year	Females spawned natural	Females spawned hatchery	Mean[a] fecundity natural	Mean[a] fecundity hatchery	Number of eggs	Number of fry	Number of smolts	Progeny[b] (returning adults)
1985	4	-	3,883	-	14,843	13,401	12,922	45
1986	57	-	3,916	-	187,958	177,277	153,725	339
1987	48	-	4,096	-	196,573	164,630	152,165	190
1988	49	-	3,882	-	182,438	150,677	146,200	447
1989	28	9	3,883	2,606	133,521	103,420	99,060	243
1990	21	23	3,993	2,697	126,334	89,519	85,800	28
1991	17	11	3,741	2,517	91,275	77,232	74,060	25
1992	28	18	3,854	3,295	156,359	151,727	87,752[c]	81
1993	21	28	3,701	3,237	168,366	145,303	138,848	207
1994	22	21	4,187	3,314	161,707	132,870	130,069	34
1995	6	15	5,224	0	85,772	63,935	62,272	180
1996	18	19	3,516	2,843	117,287	80,325	76,219	260
1997	17	25	3,609	3,315	144,237	29,650	24,184	181
1998	30	14	4,023	3,035	161,019	136,027	127,939	666
1999	1	36	3,965	3,142	113,544	106,880	97,600	7
2000	3	35	3,969	3,345	128,980	123,313	102,099	
2001	29	27	3,612	3,252	184,127	174,934	146,922	
2002	22	25	3,981	3,368	169,364	151,531		

[a] 1985 and 1989 mean fecundity of natural females is average of 1986-88 and 1990-93, 1999 mean fecundity of natural fish is the based on the mean of 1986-1998 .
[b] Numbers do not include down river harvest estimates or out of basin recoveries.
[c] Number of smolts is less than actual release number. 57,316 parr were released in October 1993, with an estimated 7% survival. Total number of hatchery fish released from the 1992 brood year was 140,725. We therefore use the listed number of 87,752 as the number of smolts released.

Table 21. Percent survival by brood year for juvenile salmon and the multiplicative advantage of hatchery-reared salmon over naturally-reared salmon in the Tucannon River.

	Natural			Hatchery			Hatchery Advantage		
Brood Year	**Egg to fry**	**Fry to smolt**	**Egg to smolt**	**Egg to fry**	**Fry to smolt**	**Egg to smolt**	**Egg to fry**	**Fry to smolt**	**Egg to smolt**
1985	10.6	46.6	4.9	90.3	96.4	87.1	8.5	2.1	17.6
1986	13.1	56.7	7.4	94.3	86.7	81.8	7.2	1.5	11.0
1987	10.4	55.6	5.8	83.8	92.4	77.4	8.0	1.7	13.3
1988	15.2	54.3	8.3	82.6	97.0	80.1	5.4	1.8	9.7
1989	14.4	51.2	7.4	77.5	95.8	74.2	5.4	1.9	10.1
1990	13.2	57.4	7.6	70.9	95.8	67.9	5.4	1.7	8.9
1991	19.0	54.7	10.4	84.6	95.9	81.1	4.5	1.8	7.8
1992	14.2	49.2	7.0	97.0	57.8	56.1	6.8	1.2	8.0
1993	12.9	57.1	7.4	86.3	95.6	82.5	6.7	1.7	11.2
1994	7.1	55.0	3.9	82.2	97.9	80.4	11.6	1.8	20.7
1995	0.0	0.0	0.3	74.5	97.4	72.6	- -	- -	- -
1996	1.2	56.7	0.7	68.5	94.9	65.0	55.8	1.7	- -
1997	13.2	64.0	8.4	20.6	81.6	16.8	1.6	1.3	2.0
1998	8.7	65.2	5.6	84.5	94.1	79.5	9.8	1.4	14.1
1999	12.3	51.2	6.3	94.1	91.3	86.0	7.7	1.8	13.7
2000	13.8	44.9	6.2	95.6	82.8	79.2	6.9	1.8	12.8
2001	6.1			95.0	84.0	79.8	15.7		
2002				89.5					
Mean	10.9	51.2	6.1	81.8	90.4	73.4	10.4	1.7	11.5
SD	5.0	14.7	2.7	17.5	10.0	16.6	12.5	0.2	4.5

Table 22. Adult returns and SAR's of **natural** salmon to the Tucannon River for brood years 1985-1997.									
		Number of Adult Returns, observed and expanded (exp)[a]							
		Age 3		**Age 4**		**Age 5**		**SAR (%)**	
Brood Year	**Estimated number of smolts**	**obs**	**exp**	**obs**	**exp**	**obs**	**exp**	**w/ jacks**	**no jacks**
1985	42,000	8	19	110	255	36	118	0.93	0.89
1986[b]	58,200	1	2	115	376	28	90	0.80	0.80
1987	44,000	0	0	52	167	29	71	0.54	0.54
1988	37,500	1	3	136	335	74	189	1.41	1.40
1989	30,000	5	12	47	120	23	26	0.53	0.49
1990	49,500	3	8	63	72	12	14	0.19	0.17
1991	30,000	0	0	4	5	1	2	0.02	0.02
1992	50,800	2	2	84	159	16	33	0.38	0.38
1993	49,560	1	2	62	127	58	75	0.41	0.41
1994	6,000	0	0	8	10	1	2	0.20	0.20
1995	75	0	0	1	1	2	5	8.00[c]	8.00[c]
1996	1,612	0	0	27	63	2	6	4.28	4.28
1997	21,057	6	14	234	703	29	86	3.81	3.75
Geometric Mean of 1985-1997 broods								0.54	0.53

[a] Expanded numbers are calculated from the proportion of each known age salmon recovered in the river and from broodstock collections in relation to the total estimated return to the Tucannon River. Expansions do not include down river harvest or Tucannon River fish straying to other systems.
[b] One known (expanded to two) age 6 salmon was recovered.
[c] 1995 SAR not included in mean.

Table 23. Adult returns and SAR's of **hatchery** salmon to the Tucannon River for brood years 1985-1997.

Brood Year	Estimated number of smolts	Number of Adult Returns, known and expanded (exp.) Age 3 known	Age 3 exp.	Age 4 known	Age 4 exp.	Age 5 known	Age 5 exp.	SAR (%) w/ jacks	SAR (%) no jacks
1985	12,922	9	19	25	26	0	0	0.35	0.20
1986	153,725	79	83	99	238	8	18	0.22	0.17
1987	152,165	9	22	70	151	8	17	0.12	0.11
1988	146,200	46	99	140	295	26	53	0.31	0.24
1989	99,057	7	15	100	211	14	17	0.25	0.23
1990	85,500	3	6	16	20	2	2	0.03	0.03
1991	74,058	4	5	20	20	0	0	0.03	0.03
1992	87,752	11	11	50	66	2	4	0.09	0.08
1993	138,848	11	15	93	174	15	18	0.15	0.14
1994	130,069	2	4	21	25	4	5	0.03	0.02
1995	62,272	13	16	117	160	2	4	0.29	0.26
1996	76,219	44	60	100	186	5	14	0.34	0.26
1997	24,186	7	13	59	168	0	0	0.75	0.69
Geometric Mean of 1985-1997 broods								0.15	0.13

We found a significant relationship between survival calculated from CWT returns through the Regional Mark Information System (RMIS) database and size of smolts at release, with larger fish (6-10 fish/lb) having higher survival ($r^2 = 31.3$, $P<0.05$) (Appendix E). However, years in which smaller fish (14-19 fish/lb) were released also coincided with poor ocean conditions, drought years, and flood events within the Tucannon River watershed. Decreasing the release size of smolts has allowed hatchery fish to more closely resemble wild fish and decrease the incidence of precocious fish and returning jacks, but overall survival appears to have decreased. An experimental release of fish at 15/lb and 10/lb during the same year would provide a direct comparison of differences in survival, age structure, length, and fecundity of adult returns.

While SAR's were lower for hatchery salmon, overall survival of hatchery salmon to return as adults was higher than naturally reared fish because of the early-life survival advantage provided by the hatchery (Table 21). With the exception of the 1988, 1997 and 1998 brood years, naturally produced fish have been below the replacement level (Figure 8; Table 24). Based on adult returns from the 1985-1997 broods, naturally reared salmon produced 0.5 adults for every spawner, while hatchery reared fish produced 2.0 adults.

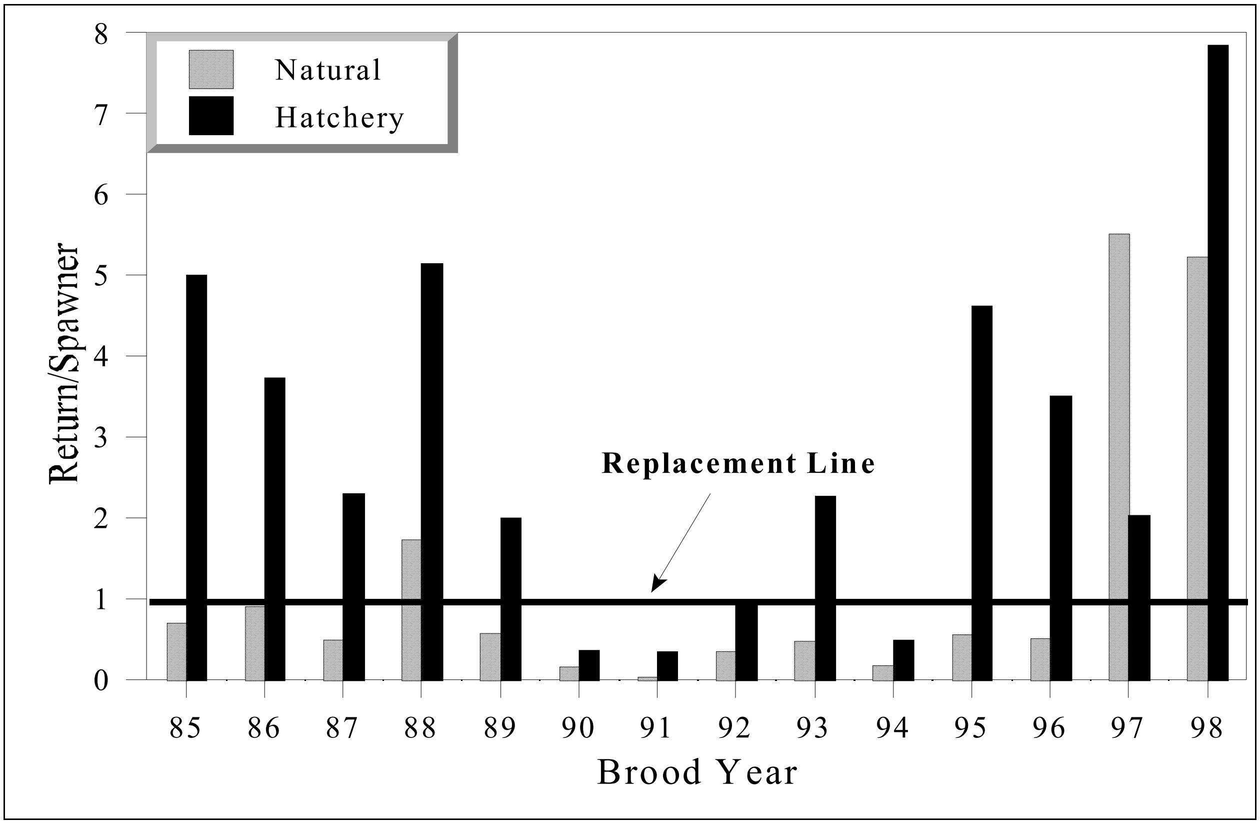

Figure 8. Return per spawner ratio (with replacement line) for the 1985-1998 brood years.

Table 24. Parent-to-progeny survival estimates of Tucannon River spring chinook salmon from 1985 through 1998 brood years (1998 incomplete).

Brood Year	Natural Salmon Number of spawners	Number of returns	Return/ spawner	Hatchery Salmon Number of spawners	Number of returns	Return/ spawner	Hatchery to Natural advantage
1985	569	392	0.69	9	45	5.00	7.2
1986	520	468	0.90	91	339	3.73	4.1
1987	481	238	0.49	83	190	2.29	4.7
1988	304	527	1.73	87	447	5.14	3.0
1989	276	158	0.57	122	243	1.99	3.5
1990	611	94	0.15	78	28	0.36	2.4
1991	390	7	0.02	72	25	0.35	17.5
1992	564	194	0.34	83	81	0.98	2.9
1993	436	204	0.47	91	207	2.27	4.8
1994	70	12	0.17	69	34	0.49	2.9
1995	11	6	0.55	39	180	4.62	8.4
1996	138	69	0.51	74	260	3.51	6.9
1997	146	803	5.50	89	181	2.03	0.4
1998	51	266	5.22	85	666	7.84	1.5
Geometric Mean			**0.54**			**1.99**	**3.7**

Fishery Contribution

An original goal of the LSRCP supplementation program was to enhance wild (natural) returns of salmon to the Tucannon River by providing 1,152 hatchery-reared fish (the number estimated to have been lost due to the construction of the Lower Snake River hydropower system) to the river. Such an increase would allow for limited harvest of the stock and increased spawning. However, hatchery adult returns have always been below the program goal. Moreover, natural escapement, with the exception of the 2001 and 2002 runs, has been low (Figure 9). Based on 1985-1997 brood year CWT recoveries from the RMIS database (Appendix E), sport and commercial harvest combined has only accounted for approximately 5.9% of the hatchery adult fish recovered annually. While exploitation has been relatively low, fishing mortality is one form of mortality fisheries managers can control. Adipose clipped hatchery fish have traditionally been targeted in the sport fishery. This hatchery fin clip was abandoned for Tucannon River spring chinook smolts starting with the 2000 BY to mitigate fishing mortality on this ESA listed population. Supplementation fish are now marked with a CWT and a red VIE tag behind the right eye. Captive brood progeny are marked only with agency-only wire tags to distinguish them from supplementation origin fish. Out-of-basin stray rates of Tucannon River spring chinook have been low (Appendix E), with an average of 3.7% of the adult hatchery fish straying to other river systems/hatcheries for brood years 1985-1997 (range 0-20%).

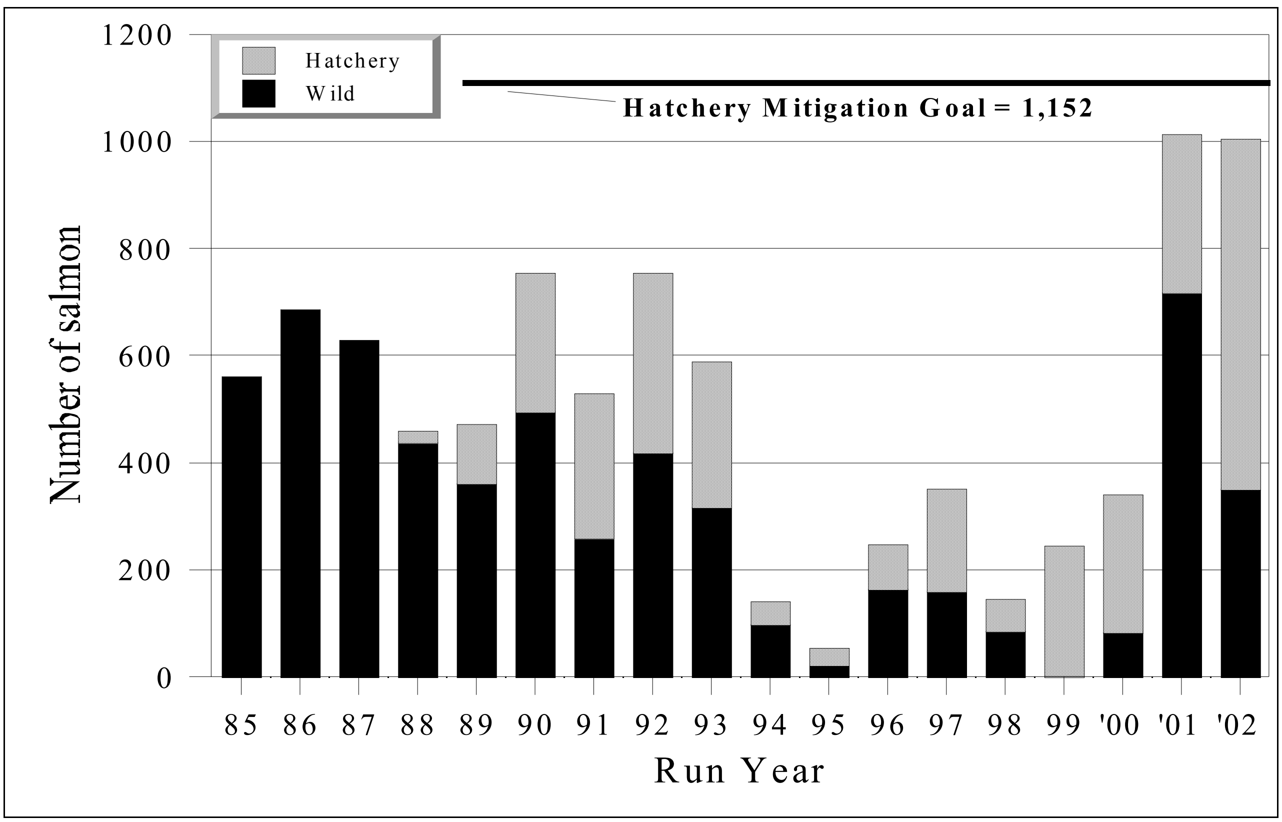

Figure 9. Total escapement for Tucannon River spring chinook salmon for the 1985-2002 run years.

Conclusions and Recommendations

Washington's LSRCP hatchery spring chinook salmon program has failed to return adequate numbers of adults to meet the mitigation goal of the program. This occurred because SARs of hatchery origin fish have consistently been below the assumed SAR of hatchery smolts as described under the LSRCP, even though hatchery returns have generally been at 2-3 times the replacement level. Further, the natural population of spring chinook salmon in the river has declined and remained below the replacement level for most years, with the majority (95%) of the mortality occurring between the green egg and smolt stages. Ocean conditions and mortality within the mainstem migration corridor have also contributed to the decline. The end result has been a slow but steady replacement of the natural population with the hatchery population. While this neither was, nor is the desired result of the program, in many ways the hatchery program has helped conserve the natural population within the river by returning enough adults to allow some spawning in the river. System survivals (in-river, ocean) must increase in the future for the hatchery program and the natural run to reach its full potential, and the spring chinook run returned to its historic levels.

Until that time, the evaluation program will continue to document and study life history survivals, genotypic and phenotypic traits, and examine procedures within the hatchery that can be improved to benefit the program and the natural population. Based on our previous studies and current data involving survival and physical characteristics we recommend the following:

1. We continue to see annual differences in phenotypic characteristics of returning salmon (i.e.,

hatchery fish are generally younger in age and less fecund than natural origin fish), yet other traits such as run and spawn time have changed little over the program's history. Further, genetic analysis to date indicates little difference between natural and hatchery populations.

Recommendation: Continue to collect as many carcasses as possible for the most accurate age composition data. Continue to assist hatchery staff with picking eyed eggs to obtain fecundity estimates for each spawned female. Collect other biological data (length, run timing, spawn timing, DNA samples, juvenile parr production, smolt trapping, and life stage survival) to continue the documentation of effects (positive or negative) that the hatchery program may have on the natural population.

2. Documenting the success of hatchery origin fish spawning in the river has become an increasingly frequent topic among managers within the Snake River Basin and with NOAA Fisheries. Little, if any, data exists on this subject. With the hatchery population in the Tucannon River slowly replacing the natural population, we are offered an opportunity to study the effects of the hatchery spawners in the natural environment.

Recommendation: Participate in a reproductive success study for spring chinook being developed jointly by NOAA Fisheries/WDFW personnel. Continue to use snorkel surveys during the summer months to estimate spring chinook parr production in the river. Examine the relationship between redd counts and the following years parr production, smolt numbers and returning adults in context of the proportion of hatchery spawners in the river and publish the results.

3. Smolt trapping is our most valuable tool in estimating the number of fish emigrating from the river. Having accurate emigration estimates and knowing the confidence limits of those estimates is pertinent in calculating reliable survival rates.

Recommendation: Work with WDFW statisticians to refine our smolt trapping methods and statistical analyses. Publish statistical methods relating abiotic factors to smolt trap efficiency rates in the scientific literature.

4. Subbasin and recovery planning for listed species in the Tucannon River will identify factors limiting the spring chinook population and strategies to recover the population. Development of a recovery goal for the population would be helpful to develop and evaluate strategies for habitat, hydropower, harvest and hatcheries.

Recommendation: Assist subbasin planning in the development of a recovery goal for spring chinook in the Tucannon River.

5. Smolt and adult detection capabilities for PIT tagged salmon within the Columbia and Snake River basins is becoming more widespread. These capabilities can help estimate survival rates for release groups to aid in evaluation of program success.

Recommendation: Utilize the SURPH2 PIT tag model software and present summaries of juvenile rates in future reports. Increase sample size of PIT tags if necessary, and document stray Tucannon fish above lower Granite Dam.

6. We have documented that hatchery juvenile (egg-parr-smolt) survival rates are considerably higher than naturally reared salmon, and hatchery smolt-to-adult return rates are much lower. We need to identify and address the factors that limit hatchery SAR's in order to meet mitigation goals.

Recommendation: Conduct a literature search and initiate a meeting between biologists working with spring chinook, both within and outside of the Snake River Basin, to compare survival rates from different watersheds under different rearing and release strategies. Provide recommendations to improve SAR, or a list of recommended research topics for managers to consider that would provide answers to improve hatchery survival.

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Appendix A

Spring chinook captured, collected, or passed upstream at the Tucannon Hatchery trap in 2002

Appendix A. Spring chinook salmon captured, collected, or passed upstream at the Tucannon Hatchery trap in 2002. (Trapping began in February; last day of trapping was September 30).						
	Captured in trap		**Collected for broodstock**		**Passed upstream**	
Date	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**
5/04		1				1
5/09		1				1
5/16		1				1
5/17	1	1	1	1		
5/18	1	4			1	4
5/19	2	1	2		2	1
5/20	2	10		6		4
5/21	3	21	2	10	1	11
5/22	3	25			3	25
5/23		5				5
5/24	1	19		10	1	9
5/25	1	11			1	11
5/26	3	22			3	22
5/27	3	29			3	29
5/28	13	45	7		6	45
5/29	18	58			18	58
5/30	15	35	5	4	10	31
5/31	4	17	3	1	1	16
6/01	5	25			5	25
6/02		1				1
6/03	5	20	4	3	1	17
6/04	7	27			7	27
6/05	2	8	2	1		7
6/06	9	37			9	37
6/07	3	13	3	3		10
6/08	1	3			1	3
6/10		2		2		
6/11		7				7
6/12	1	20	1	1		19
6/13	8	17	5		3	17

6/14	6	11	5		1	11
6/15	7	18			7	18
6/16	5	5			5	5
6/17		9				9
6/18	7	3	3	2	4	1
6/19		1				1
6/21	5	7	4	1	1	6
6/22	3	7			3	7
6/23	2	4			2	4
6/24	2	4	2			4
6/25		4				4
6/26	1				1	
6/27	1	3			1	3
6/28	2	3			2	3
7/01		2				2
7/03		1		1		
7/05		1		1		
7/09	1	1	1	1		
7/15	3	3	2	2	1	1
7/29	1	1		1	1	
7/31	1				1	

Appendix A (continued). Spring chinook salmon captured, collected, or passed upstream at the Tucannon Hatchery trap in 2002.

	Captured in trap		**Collected for broodstock**		**Passed upstream**	
Date	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**
8/11		3				3
8/15		1				1
8/22	3				3	
8/27	4	1			4	1
8/28	2	1			2	1
8/29	4	1			4	1
8/30	1	1			1	1
9/04		1		1		
9/07		5				5
9/09		3		1		2
9/10	2				2	
9/12	3	5			3	5
9/13		1				1
9/15	1	1			1	1
9/16		2		2		
Totals	**178**	**600**	**52**	**55**	**126**	**545**
Corrected #'s after spawning[1]	**168**	**610**	**42**	**65**	**126**	**545**

[1] Ten fish with intact adipose fins were subsequently identified to be of hatchery origin based on scale pattern analysis.

Appendix B

Movements of ten radio tagged female captive brood adults released into the Tucannon River, 2002

Appendix B. Movements of ten radio tagged female captive brood adults released into the Tucannon River, 2002.			
Channel/Code Date	**Tucannon Rkm**	**Location**	**Comments**
9/165			
7/16/02		Lyons Ferry Hatchery	Length at tagging – 58.0 cm.
8/20/02	74.5	Panjab Bridge	Released into river.
8/27/02	72.0	3rd Cattle guard	
8/30/02	73.0	100 m above C.C. Br.	
9/05/02	73.0	100 m above C.C. Br.	Drive by.
9/09/02	72.8	Below C.C. Bridge	Between campground and cattle guard.
9/13/02	72.9	Below C.C. Bridge	R.B. lower end of habitat site, by new redd.
9/16/02	72.9	Below C.C. Bridge	L.B. below rocks, with wild male.
9/20/02	72.9	Below C.C. Bridge	Area where she was digging now small TD.
9/23/02	72.9	Below C.C. Bridge	Fungused eyes, fins, tail frayed.
9/25/02	72.9	Below C.C. Bridge	Recovered tag and fish, 100% spent.
9/167			
7/16/02		Lyons Ferry Hatchery	Length at tagging – 55.5 cm.
8/20/02	74.5	Panjab Bridge	Released into river.
8/27/02	73.2	HMA5-S Side Channel	
8/30/02	73.3	Log jam below log weir	
9/05/02	72.9	Cow Camp Bridge	Drive by.
9/09/02	73.0	100 m above C.C. Br.	By redd 2-6, with other fish, wild male close by.
9/13/02	73.0	100 m above C.C. Br.	Recovered tag and fish - did not spawn.
9/171			
7/16/02		Lyons Ferry Hatchery	Length at tagging – 56.5 cm.
8/20/02	74.5	Panjab Bridge	Released into river.
8/27/02	73.2	HMA5-S Side Channel	
8/30/02	73.2	HMA5-S Side Channel	
9/05/02	73.2	Between C.C. & C.G. 9	Drive by.
9/09/02	73.4	Above C.C. Br. .35 km	Log jam near 9/04/02JD test dig.

9/13/02	74.5	Below Panjab Ck. mouth	Went down to pool w/ 9/183 then upstream.
9/16/02	73.6	C.G. 9 lower entrance	Drive by.
9/20/02	73.6	S.C. at C.G. 9	Near new redds in S.C., not actively digging.
9/23/02	73.4	Log jam above rock sill	Recovered tag and fish. Fish partially eaten.
9/179			
7/16/02		Lyons Ferry Hatchery	Length at tagging – 55.5 cm.
8/20/02	74.5	Panjab Bridge	Released into river.
8/27/02		Ladybug Flat?	Couldn't locate – heard chirps near Ladybug.
8/30/02		Not Found	Couldn't locate.
9/05-09/02	77.7	Ladybug Flat	Run and pool under poplar, fish moving around.
9/13-16/02	77.7	Ladybug Flat	Under alder, about 25 m upstream of path sign.
9/20/02	77.7	Ladybug Flat	Recovered tag only. Tag found between rocks. Probably poached.

Appendix B (continued). Movements of ten radio tagged female captive brood adults released into the Tucannon River, 2002.

Channel/Code Date	Tucannon Rkm	Location	Comments
9/183			
7/16/02		Lyons Ferry Hatchery	Length at tagging – 52.0 cm.
8/20/02	74.5	Panjab Bridge	Released into river.
8/27/02	74.4	Below Panjab Bridge	
8/30/02	74.5	Panjab Bridge	
9/05/02	74.5	Above Panjab Bridge	In 2nd pool above bridge.
9/09/02	74.5	Above Panjab Bridge	In 2nd pool above bridge.
9/13/02	74.5	Above Panjab Bridge	In 2nd pool above bridge.
9/16/02	74.5	Above Panjab Bridge	Drive by.
9/20/02	74.5	Above Panjab Bridge	Recovered tag only on bank – probably poached.
9/184			
7/16/02		Lyons Ferry Hatchery	Length at tagging – 51.0 cm.
8/20/02	74.5	Panjab Bridge	Released into river.
8/27/02	74.5	Panjab Bridge	
8/30/02	74.6	Wilderness C.G. 1	
9/05/02	74.6	Info. Sign below C.G. 1	Below redd 3-7MH, saw fish.
9/09/02	72.9	Below Cow Camp Bridge	Upper end of camping area.
9/13/02	69.0	Below Cattle Chute Area	Drive by.
9/16/02	69.0	Below Cattle Chute Area	Fish fungused – will not live long.
9/20/02	68.7	Above Camp Wooten Cabins	In log jam at lower end of side channel.
9/23/02	68.7	HMA 15 – Above Cabins	Drive by.
9/192			
7/16/02		Lyons Ferry Hatchery	Length at tagging – 50.0 cm.
8/20/02	74.5	Panjab Bridge	Released into river.
8/27/02		Ladybug?	Couldn't locate – heard chirps near Ladybug.
8/30/02	74.4	Below Panjab Bridge	
9/05/02	74.7	Wild C.G. 1	Saw fish in pool across from 2 week old redd.

9/09/02	74.5	100 m below main info. sign	Wood cutting area sign.
9/13/02	74.6	Below C.G. 1	Beside redd 4-4, not on redd though.
9/16/02	73.7	C.G. 9	Drive by.
9/20/02	73.6	S.C. at C.G. 9	Near new redds in S.C., not actively digging.
9/23/02	73.6	S.C. at C.G. 9	Near redd 5-3 (9-18-02JD).
9/27/02	73.6	Below C.G. 9	Recovered tag and fish – 100% spawned.
9/193			
7/16/02		Lyons Ferry Hatchery	Length at tagging – 51.0 cm.
8/20/02	74.5	Panjab Bridge	Released into river.
8/27/02	72.0	3rd Cattle Guard	
8/30/02	73.0	100 m above C.C. Bridge	
9/05/02	73.5	Lower end C.G. 9	Couldn't pinpoint – tag may be out of fish.
9/09/02	73.5	Across from house, above C.C.	In run 10 m above National Forest Boundary.
9/13/02	73.5	Across from house, above C.C.	Tag in otter den.
9/23/02	73.5	Across from house, above C.C.	Tag in den.

Appendix B (continued). Movements of ten radio tagged female captive brood adults released into the Tucannon River, 2002.

Channel/Code Date	Tucannon Rkm	Location	Comments
9/203			
7/16/02		Lyons Ferry Hatchery	Length at tagging – 49.0 cm.
8/20/02	74.5	Panjab Bridge	Released into river.
8/27/02	74.5	Panjab Bridge	
8/30/02		Not Found	Lost contact.
9/05/02		Not Found	Lost contact.
9/205			
7/16/02		Lyons Ferry Hatchery	Length at tagging – 47.0 cm.
8/20/02	74.5	Panjab Bridge	Released into river.
8/27/02	74.4	Below Panjab Bridge	
8/30/02		Not Found	
9/05/02	76.6	1 km below Ladybug Flat	Fish holding under spruce over river.
9/09/02	76.6	1 km below Ladybug Flat	50 m downstream of road 025.
9/13/02	76.6	1 km below Ladybug Flat	Recovered tag only under brush on bank. Probably poached.

Appendix C

Estimated Total Run-Size of Tucannon River Spring Chinook Salmon (1985-2002)

Appendix C. Total estimated run-size of spring chinook salmon to the Tucannon River, 1985-2002.							
Run Year	**Wild Jacks**	**Wild Adults**	**Total Wild**	**Hatchery Jacks**	**Hatchery Adults**	**Total Hatchery**	**Total Run-Size**
1985	0	591	591	0	0	0	591
1986	6	630	636	0	0	0	636
1987	6	576	582	0	0	0	582
1988	19	391	410	19	0	19	429
1989	2	334	336	83	26	109	445
1990	0	494	494	22	238	260	754
1991	3	257	260	99	169	268	528
1992	12	406	418	15	320	335	753
1993	8	309	317	6	266	272	589
1994	0	98	98	5	37	42	140
1995	2	19	21	11	22	33	54
1996	2	145	147	15	70	85	232
1997	0	134	134	3	151	154	288
1998	0	85	85	16	43	59	144
1999	0	3	3	60	182	242	245
2000	14	68	82	16	241	257	339
2001	9	709	718	111	183	294	1,012
2002	9	341	350	11	644	655	1,005

Appendix D

Numbers and density estimates (fish/100 m^2) of juvenile salmon counted by snorkel surveys in the Tucannon River in 2002

Appendix D. Numbers and density estimates of subyearling and yearling natural salmon, and yearling hatchery chinook counted by snorkel surveys in the Tucannon River, 2002.

			Number of Salmon				Density (fish/100m^2)		
			Natural		Hatchery		Natural		Hatchery
Stratum	Site	Date	0+	> 1+	> 1+	Snorkeled Area (m^2)	0+	> 1+	> 1+
Marengo	TUC01	8/12	37	1	0	423	8.74	0.24	0.00
↓	01A	8/12	28	0	0	336	8.33	0.00	0.00
	TUC02	8/12	32	0	0	656	4.88	0.00	0.00
	02A	8/12	89	0	0	556	16.00	0.00	0.00
	TUC03	8/12	13	0	0	520	2.50	0.00	0.00
	03A	8/12	88	0	0	482	18.26	0.00	0.00
Hartsock	TUC04	8/12	49	0	0	423	11.58	0.00	0.00
↓	04A	8/12	80	0	0	498	16.06	0.00	0.00
	TUCO5	8/12	72	0	0	574	12.54	0.00	0.00
	05A	8/12	102	0	0	404	25.25	0.00	0.00
	TUC06	8/12	52	0	0	620	8.39	0.00	0.00
	06A	8/12	28	0	0	574	4.88	0.00	0.00
	TUC07	8/12	111	1	0	995	11.16	0.10	0.00
	07A	8/12	137	0	0	773	17.72	0.00	0.00
	TUC08	8/12	153	0	0	484	31.61	0.00	0.00
	08A	8/12	25	0	0	570	4.39	0.00	0.00
	TUC09	8/12	92	1	0	575	16.00	0.17	0.00
	09A	8/12	55	0	0	567	9.70	0.00	0.00
	TUC10	8/12	63	1	0	381	16.54	0.26	0.00
	010A	8/12	50	0	0	483	10.35	0.00	0.00
HMA	TUC11	8/12	61	0	0	753	8.10	0.00	0.00
↓	011A	8/12	83	0	0	583	14.24	0.00	0.00
	TUC13	8/12	120	0	0	631	19.02	0.00	0.00
	13A	8/12	68	0	0	638	10.66	0.00	0.00
	TUC14	8/12	187	1	0	552	33.88	0.18	0.00
	14A	8/12	92	1	0	575	16.00	0.17	0.00
	TUC16	8/12	110	2	0	415	26.51	0.48	0.00
	16A	8/12	53	0	0	553	9.58	0.00	0.00
	TUC17	8/12	137	2	0	615	22.28	0.33	0.00

	17A	8/12	34	0	0	755	4.50	0.00	0.00
	TUC19	8/13	15	0	0	606	2.48	0.00	0.00
	19A	8/13	96	0	0	495	19.39	0.00	0.00
	TUC20	8/13	66	0	0	544	12.13	0.00	0.00
	20A	8/13	42	0	0	571	7.36	0.00	0.00

Appendix D. Numbers and density estimates of subyearling and yearling natural salmon, and yearling hatchery chinook counted by snorkel surveys in the Tucannon River, 2002**.**

			Number of Salmon				**Density (fish/100m^2)**		
			Natural		**Hatchery**		**Natural**		**Hatchery**
Stratum	**Site**	**Date**	**0+**	**> 1+**	**> 1+**	**Snorkeled Area (m^2)**	**0+**	**> 1+**	**> 1+**
HMA	TUC21	8/13	70	3	0	648	10.80	0.46	0.00
(cont.)	21A	8/13	36	0	0	656	5.49	0.00	0.00
↓	TUC22	8/13	57	6	0	512	11.13	1.17	0.00
	22A	8/13	41	0	0	486	8.44	0.00	0.00
	TUC23	8/13	30	0	0	584	5.14	0.00	0.00
	23A	8/13	29	2	0	599	4.84	0.33	0.00
Wilderness	TUC24	8/13	76	5	0	599	12.69	0.83	0.00
↓	24A	8/13	32	4	0	387	8.27	1.03	0.00
	TUC25	8/13	15	1	0	365	4.11	0.27	0.00
	25A	8/13	84	2	0	290	28.97	0.69	0.00
	TUC26	8/13	10	0	0	341	2.93	0.00	0.00
	26A	8/13	17	2	0	481	3.53	0.42	0.00
	TUC27	8/13	0	0	0	390	0.00	0.00	0.00
	27A	8/13	0	0	0	366	0.00	0.00	0.00
	TUC28	8/13	0	0	0	287	0.00	0.00	0.00
	28A	8/13	0	0	0	649	0.00	0.00	0.00
Totals			**3,017**	**35**	**0**	**26,820**			

Appendix E

Recoveries of coded-wire tagged salmon released into the Tucannon River for the 1985-1997 brood years

Appendix E. Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-1997 brood years. (Data from RMIS database.)						
Brood Year	1985		1986		1987	
Smolts Released	12,922		147,037		151,100	
Fish/Lb	6.0		10.0		9.0	
CWT Codes[1]	34/42		33/25, 41/46, 41/48		49/50	
Release Year	1987		1988		1989	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River			30	21	28	160
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll			1	2		
Lyons Ferry Hatch.[2]	32	60	136	287	53	71
F.W. Sport			1	4		
ODFW						
Test Net, Zone 4	1	1	1	1		
Treaty Ceremonial			2	4	1	2
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
CDFO						
Non-treaty Ocean Troll			1	4		
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
Total Returns	33	61	172	323	82	233
Tucannon (%)	98.4		95.4		99.1	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	1.6		1.5		0.9	
Sport Harvest (%)	0.0		3.1		0.0	
Survival	0.47		0.22		0.15	

[1] WDFW agency code prefix is 63.

[2] Fish trapped at TFH and held at LFH for spawning.

Appendix E. Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-1997 brood years. (Data from RMIS database.)

Brood Year	1988		1989		1990	
Smolts Released	139,050		97,779		85,737	
Fish/Lb	11.0		9.0		11.0	
CWT Codes[1]	01/42, 55/01		01/31, 14/61		37/25, 40/21, 43/11	
Release Year	1990		1991		1992	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	107	378	61	191	2	6
Kalama R., Wind R.						
Fish Trap - F.W.	1	0				
Treaty Troll			2	2		
Lyons Ferry Hatch.[2]	83	86	55	55	19	19
F.W. Sport	1	4				
ODFW						
Test Net, Zone 4	3	3	2	2		
Treaty Ceremonial	8	17	4	8		
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH	1	1				
Total Returns	204	489	124	258	21	25
Tucannon (%)	94.9		95.3		100.0	
Out-of-Basin (%)	0.2		0.0		0.0	
Commercial Harvest (%)	4.1		3.9		0.0	
Sport Harvest (%)	0.8		0.8		0.0	
Survival	0.35		0.26		0.03	

[1] WDFW agency code prefix is 63.

[2] Fish trapped at TFH and held at LFH for spawning.

Appendix E. Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-1997 brood years. (Data from RMIS database.)

Brood Year	1991		1992		1992	
Smolts Released	72,461		56,679		79,151	
Fish/Lb	15.0		36.0		14.0	
CWT Codes[1]	46/25, 46/47		48/23, 48/24, 48/56		48/10, 48/55, 49/05	
Release Year	1993		1993		1994	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River					11	34
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[2]	24	24	2	2	45	49
F.W. Sport						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial	1	3			1	1
Three Mile, Umatilla R.						
Spawning Ground	1	3			2	4
Fish Trap - F.W.			1	1	5	9
F.W. Sport					2	2
Hatchery						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine			1	2		
Ocean Sport						
USFWS						
Warm Springs Hatchery					3	3
Dworshak NFH						
Total Returns	26	30	4	5	69	102
Tucannon (%)	80.0		40.0		81.4	
Out-of-Basin (%)	10.0		20.0		15.7	
Commercial Harvest (%)	10.0		40.0		0.9	
Sport Harvest (%)	0.0		0.0		2.0	
Survival	0.04		0.01		0.13	

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Appendix E. Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-1997 brood years. (Data from RMIS database.)

Brood Year	1993		1994		1995	
Smolts Released	135,952		130,034		62,016	
Fish/Lb	14.0-15.0		13.0-18.0		17.0-19.0	
CWT Codes[1]	56/15, 56/17-18, 53/43-44		43/23, 56/29, 57/29		59/36, 61/40, 61/41	
Release Year	1995		1996		1997	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	42	138	3	8	36	92
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[2]	66	138	21	24	94	93
F.W. Sport						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial	3	3				
Three Mile, Umatilla R.						
Spawning Ground	3	3			1	1
Fish Trap - F.W.	1	1				
F.W. Sport						
Hatchery	1	1			1	1
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport	1	3				
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
Total Returns	117	287	24	32	132	187
Tucannon (%)	96.2		100.0		98.9	
Out-of-Basin (%)	1.7		0.0		1.1	
Commercial Harvest (%)	1.0		0.0		0.0	
Sport Harvest (%)	1.0		0.0		0.0	
Survival	0.21		0.02		0.30	

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[2] Fish trapped at TFH and held at LFH for spawning.

Appendix E. Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-1997 brood years. (Data from RMIS database.)						
Brood Year	1996		1997		1998	
Smolts Released	76,028		23,509		124,093	
Fish/Lb	16.0		16.0		13.0	
CWT Codes[1]	03/59-60, 61/24-25		61/32		12/11	
Release Year	1998		1999		2000	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	43	139	17	85	30	135
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[2]	96	99	44	46	7	7
F.W. Sport						
Non-treaty Ocean Troll					1	2
ODFW						
Test Net, Zone 4						
Treaty Ceremonial						
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.	1	1	2	2	6	6
F.W. Sport					1	35
Hatchery	2	2	1	1		
Columbia R. Gillnet			2	8		
Columbia R. Sport			1	9		
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
Total Returns	142	241	67	151	45	185
Tucannon (%)	98.8		86.8			
Out-of-Basin (%)	1.2		2.0			
Commercial Harvest (%)	0.0		5.3		Incomplete Returns	
Sport Harvest (%)	0.0		6.0			
Survival	0.32		0.64			

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[2] Fish trapped at TFH and held at LFH for spawning.